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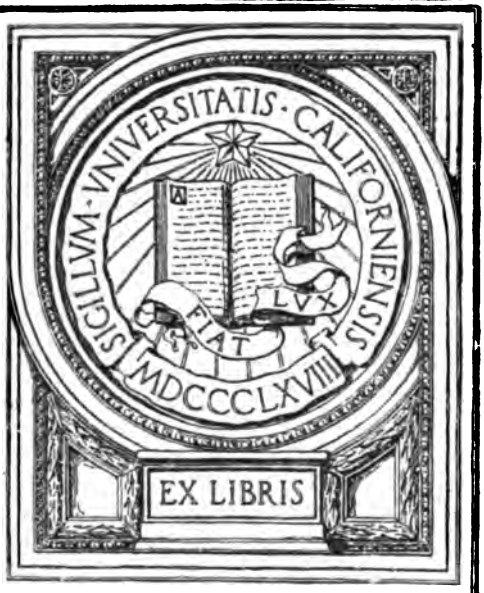

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THE

AMERICAN CHEMICAL SOCIETY.

I.—Proceedings of the First Meeting for Organization, New York, April 6, 1876.

The meeting, to which the chemists residing in New York city and its vicinity had been invited, was held at the rooms of the N. Y. College of Pharmacy, University Building, and the following gentlemen were present:—M. Alsberg, J. P. Battershall, F. M. Baumgarten, H. C. Bolton, A. Bourgognon, Arno Behr, C. F. Chandler, P. Casamajor, Chas. A. Doremus, F. A. C. Degenhardt, Hermann Endemann, E. P. Eastwick, T. Egleston, Charles Froebel, F. A. Grund, Wm. E. Gifford, W. M. Habirshaw, Fred. Hoffmann, Harwick, St. Krackowizer, Fred. Kammerer, O. H. Krause, A. R. Leeds, A. R. Ledoux, L. H. Laudy, Gideon E. Moore, H. E. Niese, W. H. Nichols, Anthony Pirtz, —— Prochalzka, P. de P. Ricketts, Charles Rice, Chas. M. Stilwell, Waldron Shapleigh, Isidor Walz.—Total, 85.

Messrs. Amend, Goldmark, Sticht and Wendt had sent letters regretting their inability to attend, but approving the objects of the meeting and promising to join the society to be organized.

On motion, Prof. Charles F. Chandler was elected president and Isidor Walz secretary of the meeting.

Prof. Chandler took the chair and said that the want of such a society as they had met to organize, had long been felt among chemists, and it promised to have a wide field of usefulness. The self-constituted committee which had taken the matter in charge had been astonished to find that there were about one hundred and ten chemists in this and neighboring

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cities, whose training and pursuits rendered them fit members of a chemical society. Nearly fifty of these had promised to join the proposed society, and, in addition, a large number of non-resident members had responded to the invitations sent out. The ultimate object was to bring the chemists together in scientific and social intercourse, to secure rooms which should be open in the day and evening, and to establish there a library of reference and a chemical museum. The speaker then called upon the secretary to give the details of the steps which had been taken by the original committee.

Dr. WALZ presented the following report:

I respond with pleasure to the request to give you the brief history of the movement which has culminated in bringing us together to-night. The want of a professional organization among chemists has been frequently deplored; and it was felt that sooner or later a chemical society must and would be formed to bring the members of our profession into closer personal relations, and to stimulate and concentrate original research. At the beginning of this year it was suggested, in informal conversation, that this might prove to be as favorable a time as any to organize such a society, if the want was a real one. It was also clear, that to establish it on a sound basis and make success certain, all classes of chemists who had received the proper training should be interested in the movement, whether engaged as teachers, as manufacturers, as analytical or technical chemists, or in any other pursuit in which chemistry formed a leading part. It was intended, therefore, to make the committee charged with the preliminaries of the organization a representative one in this distinction; and as the list of its members is by this time quite familiar to you, you may judge for yourselves whether we have succeeded in making it so.

A list of chemists in this city and vicinity was first

made out, and though it was by no means complete, we found to our astonishment that there were nearly, if not quite, one hundred chemists in this neighborhood who might properly be admitted as members of the proposed society. The following circular was prepared and mailed to these gentlemen toward the end of January:

NEW YORK, *January* 22d, 1876.

DEAR SIR:—For some time past many chemists of this city and vicinity have felt the want, and deplored the absence of an association, such as exist among other professions, which would lead to a better understanding and a closer acquaintance among its members; in which scientific and practical subjects relating to our special science might be discussed, and means devised in the common interest of the profession. Widely scattered as the chemists in this neighborhood are, such an association would become the centre of a pleasant personal intercourse, and of an interchange of views, experiences and researches which would benefit all concerned.

The undersigned, believing the present an opportune time for establishing a "Chemical Society" in New York, respectfully invite your co-operation, and would be pleased to receive an early expression of your views on the subject. As soon as a sufficient number of assenting replies have been received, it is proposed to call a meeting for the purpose of forming a permanent organization.

CHAS. F. CHANDLER,	HENRY MORTON,
W. M. HABIRSHAW,	ISIDOR WALZ,
H. ENDEMANN,	F. HOFMANN,
M. ALSBERG,	P. CASAMAJOR.

In response to this circular we received about forty verbal or written assurances of sympathy and co-operation. Gratified by the unexpected interest shown, the committee decided to make an attempt to form a national instead of a merely local society; and in order to test the disposition of the chemists in the country towards such a project, the committee invited a further number of members of the profession to take part in its deliberations, which resulted in issuing

the following circular, which was mailed to about 220 addresses:

NEW YORK, *March* 22d, 1876.

DEAR SIR:—Several weeks ago the undersigned issued an invitation to the chemists of this vicinity, requesting their co-operation toward the organization of a *local* Chemical Society. The response was so unexpectedly satisfactory, that on further consultation it was deemed opportune to attempt the formation of a *national* Society, somewhat on the plan of those in such successful operation in France, Germany, and England. It is believed that the existence of such a Society in this country would prove a powerful and healthy stimulus to original research among us, and that it would awaken and develop much talent now wasting in isolation, besides bringing the members of the association into closer union, and ensuring a better appreciation of our science and its students on the part of the general public. Guided by these considerations, we have, in consultation with other members of the profession, drafted the accompanying Constitution and By-Laws, which we submit respectfully to your kind consideration.

Among the objects contemplated are the fitting up of permanent rooms as the head-quarters of the Society, and in connection therewith the establishment of a library of reference, and the gradual collection of a chemical museum. It is also proposed to hold at least one meeting in each year outside of this city, at such a time and in such a place as to make attendance on the part of non-resident members more convenient and representative.

The proceedings of the Society will be published and sent to the members.

If these views and objects meet with your approval, please sign and return the postal card enclosed.

CHAS. F. CHANDLER,	HENRY MORTON,
W. M. HABIRSHAW,	ISIDOR WALZ,
H. ENDEMANN,	FRED. HOFMANN,
M. ALSBERG,	P. CASAMAJOR.

This circular was accompanied by a draft of a Constitution and By-Laws, which the Committee prepared on the model of those of the German and French Chemical Societies, and in framing which we had in view the utmost simplicity and elasticity; and also

by the postal card appended, by returning which to the Committee with a signature, the approval of our course could be readily signified.

[N.B.—This draft is here omitted, as it is given below in the form in which it was finally adopted.]

Dear Sir:—I shall be pleased to join the proposed AMERICAN CHEMICAL SOCIETY.

Full Name,.....
Town,.....
County,.....
State,.....

To the Committee

AMERICAN CHEMICAL SOCIETY,

P.O. Box 1,396, NEW YORK CITY.

Although the circular and the accompanying documents were only mailed to non-resident chemists as late as March 28th, assenting replies have been received during the short space of time that has elapsed from the following non-resident chemists, all of whom have signified their desire to join the proposed society:

Isaac Adams, Jr., 6 Alexander Ave., Boston, Mass.

Wilbur O. Atwater, Middletown, Middlesex Co., Conn.

Geo. F. Barker, Univ'y of Penna., Philadelphia, Pa.

Rachel L. Bodley, Philadelphia, Pa.

John J. Brown, Syracuse, Onondaga, N. Y.

William H. Chandler, Bethlehem, Northampton Co., Pa.

S. Cabot, Jr., Boston, Mass.

Peter Collier, Burlington, Chittenden Co., Vt.

Charles M. Cresson, M.D., Philadelphia, Pa.

Thomas M. Drown, Easton, Northampton Co., Pa.

Albert Ethelbert Ebert, Chicago (584 State St.), Ill.

Arthur H. Elliott, Highlands Chem. and Min'g. Co., Putman Co., N. Y.

Frederick M. Endlich, Smithsonian Institution, Washington, D. C.

Charles A. Goessmann, Amherst, Hampshire Co., Mass.

Traill Green, Easton, Northampton Co., Pa.

Hugh Hamilton, Harrisburg, Dauphin Co., Pa.

M. B. Hardin, Va. Military Institute, Lexington, Rockbridge Co., Va.

Maurice Hasenclever, Lawrence, Essex Co., Mass.

S. Dana Hayes, Boston, Mass.

Benjamin S. Hedrick, Washington, D. C.

William Barker Hills, Cambridge, Middlesex Co., Mass.

Gustavus Hinrichs, Iowa City, Johnson Co., Iowa.

Henry Cowell Humphrey, Philadelphia, Pa.

Henry Jameson, Indianapolis, Marion Co., Ind.

Charles McIntire, Easton, Northampton Co., Pa.

Robert Clark McKedzie, Lansing, Ingham Co., Mich.

Hermann Kersting, East Boston, Mass.

William J. Land, Atlanta, Fulton Co., Ga.

S. A. Lattimore, Rochester, N. Y.

Gustav Adolph Liebig, Baltimore, Md.

John Berrien Lindsley, Nashville, Tenn.

John M. Maisch, Philadelphia, Pa.

J. W. Mallett, Univ'y of Virginia, Albemarle Co., Va.

John P. Marshall, Somerville, Middlesex Co., Mass.

J. B. Marvin, Louisville, Ky.

John Mudge Merrick, 59 Broad St., Boston, Mass.

William Maunch Mew, Washington, D. C.

Thos. T. Morrell, Johnstown, Cambria Co., Pa.

Chas. E. Munroe, Annapolis, Anne Arundel Co., Md. U. S. Naval Academy.

Wm. McMurtrie, Dep't of Agriculture, Washington, D. C.

Henry B. Nason, Troy, Rensselaer Co., N. Y.

Maurice Perkins, Schenectady, N. Y.

Albert Benjamin Prescott, Ann Arbor, Mich.

Robert E. Rogers, 1,004 Walnut St., Philadelphia, Pa.

Stephen P. Sharples, Boston, Mass.

Wm. Simon, Med. Coll. of Pharmacy, Baltimore, Md.

Henry Wheaton Vaughan, Providence, R. I.

Shippen Wallace, 113 Walnut St., Philadelphia, Pa.

Chas. P. Williams, Rolla, Phelps Co., Mo.

Theodore G. Wormley, Columbus, Ohio.

Henry A. Weber, Champaign, Champaign Co., Ill.

Adolphe Amedée Fersqet 1,322 Marshall St., Philadelphia, Pa.

Paul Schweitzer, Columbia, Boone Co., Mo.—Total 60.

A few days later, the following invitation was issued to resident chemists.

NEW YORK, *March* 27th, 1876.

DEAR SIR:—A meeting for organizing the American Chemical Society will be held on Thursday evening, April 6th, 1876, at 8 o'clock P.M., in the Lecture Room of the College of Pharmacy, University Building, corner Waverley Place and University Place.

Your attendance is earnestly requested.

CHAS. F. CHANDLER,	HENRY MORTON,
W. M. HABIRSHAW,	ISIDOR WALZ,
H. ENDEMANN,	FRED. HOFFMANN,
M. ALSBERG,	P. CASAMAJOR.

A number of others, who have not yet replied, may be confidently counted upon, and thus it appears that we shall be able to start with no less than one hundred resident and non-resident members.

One other point it is my duty to bring to your attention, and then my present task will be done. Among the gentlemen whom the committee requested to take part in its conferences, there were several of high standing in the profession, who would be an ornament to this society, and whose absence we would deeply deplore. These gentlemen, though admitting the necessity and approving the objects of the proposed Chemical Society, question its timeliness for the following reason. For sixty years there has existed in this city a scientific society known as the Lyceum

of Natural History, which of late years has fallen into a decline. A number of its members lately effected a change of the name of the society, and have gone to work to rehabilitate it, and restore it to its former health and vigor, under the title of the New York Academy of Sciences. One of the sections of this Academy is devoted exclusively to Chemistry, and holds monthly meetings. The gentlemen alluded to are of opinion that the work of our society will interfere with their own; that there are not enough chemists in the city for effective work in both organizations; and that one or the other, and possibly both, might thus be weakened and injured. The majority of our committee did not share these apprehensions, and decided that, having entered upon the movement, and induced others to interest themselves in it, it was our duty to complete the preliminaries and push on to some definite result; but at the same time it promised that the chemists of the New York Academy of Sciences, should have the fullest opportunity to lay their views before you on this occasion; and on behalf of the committee, I would bespeak for them your earnest and careful attention, though personally I cannot fall in with their views. To bring this matter in proper manner before the meeting, I now move that we proceed to organize a national Chemical Society, which shall be called the American Chemical Society.

The motion having been seconded, the President declared the subject open to discussion.

Prof. T. Egleston said that it might be advisable to organize such an association some years hence; but at present, it was questionable if it could be successful. His experience in the American Institute of Mining Engineers, and other societies, was against it. The society mentioned, with its 600 members and $6,000. income, required all its income for publishing its proceedings. Expenses will be inevitable, and the society can count upon only $500, say to the most $1,000, a

year. Even if rooms can be secured and the publications printed free of charge, the society has no library. It must have one—it must publish proceedings in a creditable and prompt way. The Lyceum of Natural History has recently been reorganized as the Academy of Sciences; has a large library, a history, and funds have been promised. At some future time, undoubtedly, we ought to have a Chemical Society, but not now. We should have to depend on outside subscriptions, for which the present is an inopportune time. It is hard to get money now—when it will be easier to obtain it, the success of such a society would be better assured. In union there is strength. Let the chemists join forces with the Chemical Section of the New York Academy of Sciences, till they shall be strong enough to cut loose and go ahead for themselves.

Dr. H. C. Bolton supported the views of the preceding speaker. He said that there had always been, and there is now, a strong nucleus of chemists at the Academy of Sciences; it having thirty-eight resident Chemists among its members; eight of its officers and sixty corresponding members are chemists. It would be unfortunate to have a division of forces. It may be objected that the proposed Society is to be a national one. Even from this point of view it is unnecessary, as this want is provided for by the Chemical Section of the American Association for the Advancement of Science. He thought the present time inopportune, though a Chemical Society at some future time is desirable.

Prof. Chandler said that it would be desirable to hear from the other side also; it would almost seem as though we had met for the purpose of deciding not to organize a Chemical Society.

Dr. I. Walz said that the apparent reluctance to discuss the subject was probably due to the fact that the chemists present had had the subject before them so long and had discussed it so thoroughly in private that

a prolonged expression of views at this meeting was deemed unnecessary. The previous speakers admitted the propriety of forming such a society sooner or later; but among the arguments adduced against its organization now, there were none that would lose their force with the lapse of time, but rather the contrary. There was no reason why the new society and the N. Y. Academy of Sciences should not work in harmony, and help, instead of weakening, each other. Their aims and objects were quite different. The new society would not only bring all chemists together and give the profession a recognized standing, but it would stimulate original research throughout the country. He also hoped that it would claim its proper ground, and speak with authority when questions of public interest arose in which chemistry ought to have the decisive word. This field had partly been occupied by societies that had no right to it, simply because we stood by and permitted it. The financial question had also been earnestly discussed by the committee, and such assurances given that rendered it morally certain that the necessary funds would be provided and financial difficulties avoided. Lastly, we had the encouragement and support of over a hundred gentlemen whom we had consulted, and this was of itself sufficient to prove the timeliness of the movement.

DR. ENDEMANN said that it was true that the New York Academy of Sciences had a fine library, but that it was not one useful to chemists; he had searched it and found hardly one work on chemical subjects.

DR. ALSBERG said that the Chemical Section of the American Association for the Advancement of Science did not fill the want which we wished to supply, as it only held annual and migratory meetings; it had done little to stir up chemists.

W. H. NICHOLS said that we did not come here

expecting to find a society ready formed, with a library and a fine building; those would come in time. He thought there was enough enthusiasm among the chemists to give us them by-and-by. We have much intelligence assembled here, and that is better than a library. He could see that much benefit would accrue to all branches of the profession from such a society as that proposed. A few years ago an Association of manufacturing chemists was started, which had not half the reasons for existence this has, being intended for sociability only; yet it had proved valuable, and endeared itself to all its members. Let us begin this society small, let it do its work well, and it will undoubtedly grow.

PROF. A. R. LEEDS said briefly he did not think the movement timely.

PROF. CHANDLER then gave some details of the proposed organization as discussed by the committee.

The motion was then put and carried, with but three dissenting votes.

W. H. NICHOLS moved that the Constitution and By-Laws offered by the committee be taken up article by article, and each article voted upon separately.

Carried.

The Constitution and By-Laws were then read and adopted in the following form:

CONSTITUTION.

ARTICLE I.

This Society shall be styled THE AMERICAN CHEMICAL SOCIETY.

ARTICLE II.

The objects of this Society shall be the encouragement and advancement of chemistry in all its branches.

ARTICLE III.

The Society shall consist of members, associates, and honorary members.

ARTICLE IV.

Only chemists shall be eligible as members or honorary members.

ARTICLE V.

The officers of the Society shall consist of

A President,
Six Vice-Presidents,
A Corresponding Secretary,
A Recording Secretary,
A Treasurer,
A Librarian,
Three Curators.

ARTICLE VI.

There shall be

a.) A Committee on Nominations, consisting of five members;

b.) A Committee on Papers and Publications, consisting of three members.

ARTICLE VII.

The officers of the Society and the Chairmen of the Committees shall constitute the Council of the Society, and shall have charge of all business not otherwise provided for.

ARTICLE VIII.

The Annual Meeting for the election of officers and committees shall be held in the month of December of each year, and a majority vote of the members present shall be necessary for an election.

ARTICLE IX.

The head-quarters of the Society shall be in the City of New York, and fifteen members shall constitute a quorum.

ARTICLE X.

Amendments to the Constitution shall be recommended by the Council of the Society, and for their adoption at the next regular meeting a two-third vote of the members present shall be necessary.

BY-LAWS.

ARTICLE I.

The regular meetings of the Society shall be held on the first Thursday of every month.

ARTICLE II.

The order of business at the regular meetings of the Society shall be as follows:

1. Reading of the minutes of the last meeting.
2. Reports of Council and Committees.
3. Election of new members.
4. Nominations of new members.
5. Reading of papers, and discussion.
6. Announcement of papers to be read at the next meeting.
7. Miscellaneous business.
8. Adjournment.

ARTICLE III.

The order of business at the annual meeting shall be as follows:

1. Reading of the minutes of the last meeting.
2. Report of the President on the state of the Society.
3. Report of the Council.
4. Reports of the Treasurer, Librarian, and Curators.
5. Reports of Committees.
6. Election of Officers and Committees.
7. Miscellaneous business.
8. Election of new members.
9. Nominations of new members.
10. Reading of papers, and discussion.
11. Announcement of papers for the next meeting.
12. Adjournment.

ARTICLE IV.

The order of business at the regular meetings may be suspended for one evening, with the consent of three-fourths of the members present.

ARTICLE V.

Members residing within a radius of thirty miles from New York shall be resident members.

ARTICLE VI.

Resident members shall pay an initiation fee of $5.00. Non-resident members shall not be required to pay an initiation fee.

The annual dues of members and associates shall be $5.00.

The yearly payment of dues may be commuted by a single payment of $100.

Members and associates in arrears for dues for one year, may be dropped from the roll.

ARTICLE VII.

Special meetings may be called at any time by the Council, after five days' notice.

ARTICLE VIII.

The Funds of the Society shall be deposited in the Chemical Bank of New York, and all checks and warrants must be countersigned by the President and Treasurer jointly.

ARTICLE IX.

The duties of the Officers and of the Committees of the Society shall be similar to those generally devolving upon the officers and committees designated by their names and titles.

ARTICLE X.

No articles of these By-Laws shall be altered or amended except after two weeks' notice of the intended change. The assent of two-thirds of the members present is requisite to effect such an alteration.

W. H. NICHOLS moved that the Constitution and By-Laws be adopted as a whole, and declared to be the Constitution and By-Laws of the American Chemical Society.

The motion was carried.

W. M. HABIRSHAW moved that the president appoint a Nominating Committee, to propose a list of officers for the society, to be voted upon at the next meeting.

Carried.

The PRESIDENT appointed Messrs. Habirshaw, Endemann, Casamajor, Nichols, and Krackowizer on the nominating committee, which then withdrew for deliberation.

The SECRETARY proposed the following resolution:

Resolved, That the society tenders its thanks to the president and trustees of the New York College of Pharmacy for their kindness and courtesy in tendering us the gratuitous use of their rooms for the evening.

The resolution was adopted.

DR. FRED. HOFMANN said that he was authorized by the president and trustees of the New York College of Pharmacy to tender to the new society the gratuitous use of their rooms till the society should secure permanent accommodation.

On motion, it was resolved to accept the offer for the immediate future.

A recess was then taken till the return of the Nominating Committee.

W. M. HABIRSHAW reported the following nominations on behalf of the Nominating Committee:

President.—John W. Draper.

Vice-Presidents.—J. Lawrence Smith, F. A. Genth, E. Hilgard, J. W. Mallet, C. F. Chandler, Henry Morton.

Corresponding Secretary.—H. C. Bolton.

Recording Secretary.—I. Walz.

Treasurer.—W. M. Habirshaw.

Librarian.—P. Casamajor.

Curators.—E. Sherer, E. Waller, F. Hofmann.

Committee on Nominations.—C. A. Joy, M. Alsberg, S. St. John, C. Fröbel, E. P. Eastwick.

Committee on Papers and Publications.—A. R. Gallatin, H. Endemann, A. R. Leeds.

Mr. BAUMGARTEN moved that the report of the Nominating Committee be accepted.

Carried.

On motion, the Nominating Committee was instructed to communicate with the nominees, and in cases of refusals, to propose other nominations to the society in ample time to notify the members before the election.

On motion of Prof. CHANDLER, it was

Resolved, That the chemists present at this meeting, and those who shall have replied favorably to the invitations by their presence or in writing before the first regular meeting, be, and hereby are, constituted members of the society.

I. WALZ moved that when the society adjourns, it shall adjourn to meet again on the first Thursday in May, at the same time and place.

W. M. HABIRSHAW moved to amend this motion by altering the date to April 20th.

The amendment was carried, and also the motion, as amended.

Fred. HOFMANN moved a vote of thanks to the president of the evening, and called upon the secretary to put the question.

The motion was carried.

W. H. NICHOLS moved a similar vote of thanks to the temporary secretary.

Carried.

Adjourned.

II.—PROCEEDINGS OF THE SECOND MEETING FOR ORGANIZATION.

April 20th, 1876.

PRESENT, twenty-seven resident members.

Mr. E. P. EASTWICK was elected president pro tem.

The reading of the minutes of the previous meeting was dispensed with.

The President announced that since the last meeting 21 non-resident chemists had signified their desire to join the society, raising the total of non-resident members to 74.

W. M. HABIRSHAW reported a list of officers on behalf of the Nominating Committee. On motion, the report was accepted.

On motion, it was resolved to proceed with the election of officers and committees.

On motion, the President was directed to appoint two tellers of election. The President appointed Messrs. W. H. Nichols and H. Endemann.

The election then proceeded, and the tellers announced that 27 votes had been cast, and the following officers unanimously elected:

President.—John W. Draper.

Vice-Presidents.—J. Lawrence Smith, Frederick A. Genth, E. Hilgard, J. W. Mallet, Charles F. Chandler, Henry Morton.

Corresponding Secretary.—George F. Barker.

Recording Secretary.—Isidor Walz.

Treasurer.—W. M. Habirshaw.

Librarian.—P. Casamajor.

Curators.—Edward Sherer, W. H. Nichols, Fred'k Hoffmann.

Committee on Papers and Publications.—Albert R. Leeds, Herrmann Endemann, Elwyn Waller.

Committee on Nominations.—E. P. Eastwick, M. Alsberg, S. St. John, Charles Fröbel, Chas. M. Stillwell.

On motion, the President was directed to appoint a committee of three on rooms for the society. The President appointed Chas. F. Chandler, I. Walz, and F. M. Baumgarten as such committee.

On motion, the meeting resolved itself into a committee of the whole, in order to discuss views and plans for future guidance.

When the Committee rose, W. H. NICHOLS, on its

behalf, reported to the Society a recommendation that besides the regular meetings, more informal meetings of the resident members be held, which would tend to bring the members into closer intercourse, and enable them to discuss the matters of minor importance not suited to the dignity of the regular meetings.

On motion, the report was accepted, and it was

Resolved, That informal meetings of the resident members of the Society be held on the third Monday of every month.

On motion of W. M. HABIRSHAW, the secretary was authorized to print 300 copies of the Constitution and By-Laws, together with a list of officers and members of the Society.

The PRESIDENT announced that the first regular meeting of the Society would be held on May 4th, and announced that a paper would be read by Dr. H. Endemann, "On the Determination of the Relative Effectiveness of Disinfectants," and one by Mr. P. Casamajor, "On an Iron Amalgam."

The meeting then adjourned.

I.—PROCEEDINGS.

Regular Meeting, May 4th, 1876.

VICE-PRESIDENT C. F. CHANDLER in the Chair; thirty members present.

The reading of the minutes of the last meeting was dispensed with. The chair submitted a report from the Council of the Society. [N. B. The suggestions contained in this report were adopted by the Society; *vide* below.—SEC'Y.]

The following gentlemen were proposed as members: F. Spangenberg, Ph.D., H. A. Mott, Jr., Hector C. Havemeyer, W. F. Henes, Geo. M. Miller, Prof. R. A. Fisher, Chas. A. Robbins, Ph.D., Prof. P. W Bedford, of New York; A. Baumgarten, Ph.D., of

Montreal, Canada; J. P. Kimball, Ph.D., of Bethlehem, Pa.; Prof. Sam'l P. Sadtler, Ph.D., University of Pennsylvania, Philadelphia, Pa.

The following gentlemen were proposed as associates: Willard Bartlett, Walter de F. Day, Isaac Newton, Elihu W. Root, I. Adler, M.D., Joseph Hinds, Henry Holt, all of New York.

Dr. H. Endemann read a paper "On the Determination of the Relative Effectiveness of Disinfectants," the discussion of which closed at a late hour, on which account the papers of P. Casamajor and I. Walz were laid over till the next meeting.

I. Walz stated as a preliminary communication that he had found vanadium in magnetic iron ore from the Church Mine, Van Syckles' Corner, N. J., to the amount of 0.3–0.4 per cent.

On motion, Waldron Shapleigh was elected a member of the Committee on papers and publications.

On motion, the third Thursday, instead of the third Monday, of each month, was fixed as the date of the informal meetings.

The following rules were adopted:

RULE I. No vote of thanks shall be passed to any member of the Society for any paper or communication read before the Society.

RULE II. Persons desiring to become members or associates must be proposed in writing by at least three members of the Society.

It was resolved to engage the lecture-room of the N. Y. College of Pharmacy for the regular meetings of the Society till next autumn.

It was resolved to devote the funds derived from life-membership exclusively to the formation of a library.

Adjourned till June 1st, 1876.

I. WALZ, *Secretary.*

II —Proceedings.

Regular Meeting, June 1st, 1876.

Vice-President C. F. Chandler in the Chair twenty-eight members present.

The minutes of the previous meeting were read and approved.

The Council of the Society submitted for adoption the following

Rule: The meetings of this Society shall be open to the public; but others than members and associates will not be permitted to participate in the discussions, except by special permission or request.

(This rule was subsequently adopted.)

The following members and associates were then elected by ballot:

Members.—P. W. Bedford, R. A. Fisher, Hector C. Havemeyer, W. F. Henes, J. P. Kimball, Ph.D., Geo. M. Miller, H. A. Mott, Jr., Charles A. Robbins, Ph.D., of New York; F. Spangenberg, Ph.D., A. Baumgarten, Ph.D., Montreal, Can.; S. P. Sadtler, Ph.D., Philadelphia, Pa.

Associates.—Isaac Adler, M.D., Willard Bartlett, Walter de F. Day, M.D., Joseph Hindes, Henry Holt, Isaac Newton, Elihu W. Root, of New York.

The following names were proposed for membership: Samuel Morris Lillie, T. J. Parker, E. L. Youmans, W. J. Youmans, of New York; J. G. Allyn, Chicago, Ills.; Florian Alexander, Newark, N. J.; E. H. L. Bailey, C. M. Roeper, Bethlehem, Pa.; G. W. Belcher, St. Louis, Mo.; H. B. Cornwall, Princeton, N. J.; C. Lewis Diehl, Louisville, Ky.; F. P. Dunnington, Lexington, Va.; Persifor Frazer, George A. Koenig, Howard W. Mitchell, Philadelphia, Pa.; Samuel W. Johnson, New Haven, Ct.; C. I. Lawlor, Brooklyn, L. I.; John Alva Myers, Irvington, Ind.; Richard Pearce, Black Hawk, Col.; Frederick Prime, Jr., Wil-

liam S. Sweeny, Easton, Pa.; Henry Morton Seely, Middlebury, Vt.; Herman Voorhees, New Brighton, S. I., New York; Theodore R. Wolf, Wilmington, Del.

The following were proposed as associates: Edward N. Dickinson, Geo. Elder, Jr., Adolph Hallgarten, H. O. Havemeyer, Theodore Havemeyer, John Habirshaw, F. Jones, Charles V. Mapes, F. O. Matthiessen, Wm. A. Miles, W. J. Parsons, G. W. Plympton, Charles H. Senff, Austin G. Day, Julius H. Striedinger, of New York; John H. Ricketson, Pittsburg, Pa.; Joseph Gandolfo, Brooklyn, N. Y.

The following papers were read:

"On the Amalgamation of Iron and some other Metals," by P. Casamajor;

"On the General Occurrence of Vanadium in American Magnetites," by Isidor Walz, Ph.D.;

"Action of Impure Rain Water on Lead Pipes," by Paul Schweitzer, Ph.D.;

"On the Cause of Discrepancies in the Estimation of Silver in Pig Lead," by Paul Schweitzer, Ph.D.;

"Analysis of the Gneiss of Manhattan Island," by Paul Schweitzer, Ph.D.;

"Bismuth in Lead in the Manufacture of White Lead," by H. Endemann, Ph.D.;

"Kerosene Oil," by H. B. Cornwall;

"Preliminary Note on Litmus," by Howard W. Mitchell.

After the reading of the papers, the Society resolved to tender a complimentary dinner to the foreign chemists officially connected with the Philadelphia Exhibition, and authorized the chairman to appoint the proper committees.

Adjourned to July 6th, 1876.

I. WALZ, *Recording Sec'y.*

III.—On The Determination of the Relative Effectiveness of Disinfectants.

BY HERMANN ENDEMANN, PH.D.

(Read May 4th, 1876.)

During the last ten years considerable efforts have been made to arrive at some definite conclusion regarding the nature of the substances, which constitute what has been called infectious matter and contagion —substances, which, when brought in contact with the healthy organism, are able to produce well-defined diseases.

There are physicians who take the appearance of an epidemic as something quite natural, which by no means can be prevented. They argue that there are always sporadic cases of such diseases, and an epidemic will then occur when quite a number of persons liable to take a disease are in existence. They take it for granted, that human nature, in its development, develops also these weaknesses. The causes are *omnipresent*, and it is therefore useless to protect others by quarantine and other violent measures.

The far greater number of physicians seem, however, in favor of not omnipresent and of specific substances, which, when brought into the organism, develop special diseases. The question as to the nature of this contagium is however by no means settled.

Being myself an adherent of the micrococcus, germ, or bacterium theory, I prefer to first make you acquainted with this before I shall attempt to criticise the others.

Fermentation, putrefaction, and decay are processes, which are not caused by the tendency of the atoms, which constitute the more complex substances, to form more simple chemical compounds, as was formerly believed, but by the presence of microscopical organisms.

Most of these organisms are exceedingly small, so

that it becomes necessary to use the microscope for the purpose of demonstrating their presence, and many are so very small that even the highest powers of our microscope fail to exhibit them clearly.

Plants with green leaves are able to build themselves up by the absorption and reduction of carbonic acid and other inorganic compounds. Animals live on the material, which has been produced by the plants. But between these stands this class of saprophytes, which, from a want of chlorophyllum, are unable to convert inorganic food into suitable building material, and thus are bound, though they are plants, to resort to the same mode of living as the animal. They are the great scavengers of nature, by reducing and absorbing all that has been spared by the animals, in whatever shape. They thus do infinite good, but by their parasitic nature they may likewise inflict great harm.

All living organisms are built up of cells, which in the higher plants and animals are more complicately constituted, and even in the same individual of many varied shapes. The lower the organism the less we find these variations, until at last we know of organisms, which are only one single cell, which undertake the functions of sustenance and propagation.

A new cell is in this case, as a rule, formed by the partitioning off of part of the contents; but the free formation of the cells by the concentration of the material producing the cell wall around parts of the plasma is not impossible.

This becomes more complicated, however, with the higher ærophytic forms of fungi.

If we add to their well studied and generally acknowledged various ways of fructification and propagation, that, which these organisms seem to have according to various authors, viz.: that they may also appear and thrive as yeast, their indestructibility becomes exceedingly wonderful, their manners of propa-

gation being adapted to almost every contingency. This fact, that higher fungi may appear as yeast, when brought under abnormal conditions—as, immersion into a saccharine liquid—is strongly opposed, however, by some botanists, though it is now a well-known fact that the mycelium of mucor mucedo after immersion develops into yeast, which however is able to decompose the sugar only to such an extent, that at the ordinary temperature of fermentation about four per cent of alcohol is formed.

It is further remarkable, that, while we are able to convert the mycelium of mucor mucedo into yeast, we cannot easily obtain from the yeast thus formed the original fungus. It seems that the degeneration of the cells, by being brought into such abnormal conditions prevents or at least makes the reformation difficult.

Yeast is an absorber of oxygen and grows in the same ratio as its affinity is satisfied. If oxygen is plenty, yeast will grow rapidly, but without producing alcohol. If oxygen is small in amount, the yeast will by a kind of pathological process decompose sugar into alcohol and carbonic acid.

Having shown you, now, that a degeneration of a higher fungus to yeast is possible, I come to speak of the views of Prof. Hallier in Jena. Hallier defends the independence of the plasma. If a cell comes into fluids, in which its regular development is impossible, it may happen that the cell wall becomes gradually dissolved, and that the plasma, in the shape of exceedingly small cells with a motion of their own, is liberated. These exceedingly small cells he calls micrococci. They differ in size, etc., according to the fungus to which they belong, and are able again under favorable circumstances to produce the same fungus, or other forms which may always be transformed again into this.

Beside the micrococcus and yeast-form he gives to each fungus six morphæ as which it may appear.

It has seemed to many wonderful to accept the fungi as able to indulge in such manifold transformations. On my part, and *a priori*, I would consider it far more wonderful if these manifold ways of propagation did not exist, and if each plant should remain and appear only in the same form.

Unfortunately for Hallier, he has never been able to satisfy his own colleagues as to the correctness of his observation, and on studying his writings I find always that some uncertainty is left regarding the conclusions which he draws from his observations.

The fungus which produces potato wet-rot is Peronospora infestans. In his latest writings he corrects at first some of DeBary's mistakes regarding the germination and propagation of this fungus. He describes how the mycelium works itself into the potato, and how thereafter micrococci or bacteria appear in large numbers, which destroy the whole interior of the potato in a few days, converting it into a mucilage-like fluid.

He argues: How can these bacteria reach the interior unless they are produced from the mycelium of the Peronospora, and the bacteria therefore are another form of Peronospora?

Others say: If the potato becomes injured by the mycelium of Peronospora, which draws its nourishment from it and thus alters its composition, it may produce a fertile soil for the further development of the bacteria, which are everywhere.

To meet this objection he sows another fungus on potatoes, and proves, by actual experiment, that the bacteria do not occur under these circumstances.

Now there would be no doubt, that the Peronospora is the real enemy of the potato, if we consider its presence necessary for the purpose of altering the substance of the potato, so that the life and prosperity of the bacteria become possible.

But such is not the case; the bacteria themselves infect and destroy a potato sooner than the fungus

ever will, and without its presence. This experiment, in fact, is greatly in favor of Hallier's theory. He has proved that a fertile soil for the bacteria need in no way be prepared; that they can do it themselves.

Regarding Hallier's very ingenious theory, it is to be hoped that he will be enabled, by further investigations, to make his probabilities certainties.

It cannot be my task as chemist to decide botanical questions, and I believe I have done my duty here, if I merely give you the views of the more important representatives of science.

While now Hallier looks at micrococci or bacteria as being forms of higher fungi, others consider them as independent species, which are not connected with and cannot be converted into fungi. They consist of one single cell, and multiply simply by division. These cells are spherical, oblong, etc., and when free, and not in the act of multiplying, they show a motion of their own, which, by the addition of some sulphuric acid, may be easily arrested. They grow in colonies, and each individual is surrounded and enveloped by a mucous substance. After they have thus reposed for some time, they are at once released, and then move out into the fluid, with a peculiar twisting motion.

Regarding particulars, I refer to the AMERICAN CHEMIST, Nov., 1875, where a short abstract of Cohn's paper on bacteria is given. While the higher fungus has rarely been regarded as the cause of disease, unless it be by Hallier, the bacteria have generally been credited with being such cause.

This is based on direct observation. The occurrence of higher fungi in the human organism is limited to but few instances; as, for example, the occurrence of Aspergillus glaucus in the ear. Bacteria, however, have frequently been found, and are at present considered to be the cause of most of our infectious and contagious diseases. The nature of the disease de-

pends on the nature of the bacteria which are introduced into the system.

Many experimenters could not at first find bacteria; but after they were compelled to acknowledge the fact of the presence of bacteria in the affected organism, they soon found that bacteria exist even in the healthy organism. The latest experiments, however, seem to prove that an absolutely healthy organism is actually frée from bacteria. Blood taken with the utmost precautions, and collected in glass tubes which were purified by boiling mercury in them for some time, has kept, after the tubes were sealed, for years without any other change than the dissolving of its blood corpuscles in the serum. Every-day observations, however, would be likely to bring us to the same result. The fact that the meat of diseased animals, for instance, is apt to undergo the process of putrefaction sooner, and other cases could be cited as tending to confirm this view.

Bacteria are known to be the cause of putrefaction, and if the habitations of men be situated on an area of ground where such decompositions take place on a larger scale, they are invariably unhealthy. There is, therefore, a connecting link between unhealthiness and putrefaction, which is not disputed.

The question, which, however, now may arise is, whether the ferment or the products of fermentations constitute the real poison for human constitution.

There are many, who consider bacteria as comparatively or quite harmless, while the fluids in which they were grown are, in their opinion, the real poisons.

But even if this latter were true, the theory regarding the bacteria as the cause would not be much affected. If bacteria can alter otherwise harmless fluids to forms, in which they become most virulent poisons, the bacteria remain the cause, and the developed poison is the effect; unless, as some are inclined to think,

the poison produced by the bacteria is considered to belong to the class of unorganized ferments.

Under these circumstances we might consider a disease originally produced by bacteria, but reproduced by the unorganized ferment, which owes its origin to the activity of the first.

Unorganized ferments are substances which, owing to their instability (in the presence of oxygen ?) transplant the motion of their own atoms to other substances with which they are in contact, thus producing their decomposition or other chemical changes.

If we look now to such unorganized ferments as the cause of disease, it becomes manifest that we must consider their action as partly consisting in a reproduction of themselves—an action, which thus becomes more similar to the action of organized ferments or organisms, but which at the same time would compel us to give to these albuminoids a property, which has in no case as yet been proved to exist with any of the better known substances of this class.

The theory looking to an albuminoid as the poison claims therefore the existence of as yet mythical compounds.

There are other ferments, which act merely in the manner of nitrogen dioxide in the manufacture of sulphuric acid (Pepsin). But even for these the above-mentioned difficulty exists.

And finally we might consider the sick body as producing a ferment under its own vital influence by the perversion of its natural and healthy powers.

The idea is very profound but very vague, as yet, and utterly unproved. There is in fact only one thing in favor of this theory, and that is a negative proof; viz., that many have looked in vain for bacteria in the sick body.

Considering the experiments, which are intended to prove that, not the bacteria but the products of their vitality are the poison, we find that a good many ob-

jections can be raised against their fitness to convince us of the independence of the albuminoid action.

Högyes, of Pesth, developed bacteria, which he obtained from the stools of persons sick with cholera, in Cohn's fluid, then separated the bacteria from the fluid by filtration through a clay cell and by injecting the clear fluid into the jugular vein of healthy animals caused the same symptoms which had been produced by the fluid, which yet contained the bacteria.

This treatment might have simply produced a predisposition in the animals to take up and develop the bacteria, which are considered to be in the air and water of the infected area during the time of an epidemic.

At the same time it should be mentioned, that this experiment in no way would contradict our views of the action of the bacteria, which is certainly mainly a chemical one, though the mechanical one can in no way be entirely ignored. Whether the substances which act directly upon the healthy organism were formed inside or outside of it, is of but little consequence, especially as the doses used for infection were generally taken so large that an immediate development of the disease was recognized. Klebs and Tiegel filtered and washed the bacteria with water, and found that in some cases the fluids acted as poison, not however in others.

The action of micrococci on the organism is perhaps most naturally considered to be one on the healthy constituents of the body, by which products of decomposition are rapidly formed, which cannot be removed by the existing channels so rapidly as they are formed.

I here call attention to my analyses of the blood of horses sick with epizoötic influenza, Report of the Health Dept. of New York City, 1872.

If the experiments made to uphold the theory of infection by non-organized ferments is to be upheld,

it becomes necessary to introduce these substances in minimum quantities. Wolffhügel, of Munich, says therefore: To obtain conclusive results, neither large doses should be taken for the purpose of infection, nor should the infection be undertaken in a locality which is already infected.

That bacteria, which were separated from the fluid, in which they were grown, by filtration, and which had been well washed with water, proved harmless when inoculated, cannot astonish us, when we consider, that the bacteria cannot exist and retain their vitality in fluids, which do not abound in nourishing salts, etc.

Let us consider the appearance of a fluid which has been newly infected by bacteria. If the fluid is at all adapted for this purpose, if it had been clear originally, we soon recognize a constantly increasing cloudiness. The milky appearance of the fluid remains until the bacteria cease to find food suitable to sustain their life. The bacteria then get into a state of inactivity; they fall to the bottom, and the fluid gradually becomes clear.

A good deal has been written regarding the cleansing influence, which oxygen exerts for the destruction of injurious substances (sewage) in our river waters, and though there is hardly a doubt, that some of the purification brought about in running streams is due to oxydation, it is my conviction, that it is mainly due to the great dilution of the nourishing substances.

This is not only propagated by motion, but motion itself is according to some authors sufficient to prevent or retard the development of bacteria, which then will fall to the bottom. There are therefore two agents detrimental to the life of bacteria which were grown in sewage and had found their way into the streams: dilution of the nourishment, and motion.

Oxygen is not an enemy to bacteria, but acts rather on the products, which owe their origin to the vital

process of these bodies. It is different with stagnant water. Stagnant pools are constantly supplied by subterranean or other channels in the same degree as there is loss by evaporation, but there being no outlet, other than by evaporation, the nourishing substances must accumulate and the development of the bacteria be fostered.

Our wells, which are dug to unearth the more or less stagnant subsoil water, are richer in solids and therefore, and for the smaller volume of the water, a contamination with sewage must be more detrimental than if the same had passed into a running stream.

But not only the water, even the air above it becomes thus infected, since these very minute organisms are carried off by the evaporating water. Thus they may give rise to fever and the "milk sickness" amongst cattle, which owe their origin to defective drainage; or to cholera, which is so intimately allied with the fall of the subsoil water.

The above prove, therefore, but little against the micrococcus theory. The unorganized ferment theory is, in my opinion, according to the standard of science at the present date, untenable, and if it has been proved that the poisons owe their origin to the vital activity of the bacteria in otherwise harmless fluids, why not accept these organisms at once as the cause of disease?

Might they not, in the same manner as they change Pasteur's or Cohn's fluid, change also the healthy constituents of the living body?

Beside the presence of bacteria in the sick body, there is direct evidence by no means wanting to uphold our theory.

Vaccine lymph, allowed to settle, lets its bacteria fall to the bottom. The upper layers of the vaccine are perfectly without power to produce the disease, the middle layers show it slightly, while the sediment proves to be highly infectious.

Those defending views to the contrary consider this as produced merely by surface attraction on the part of the finely divided mass of bacteria, which thus shall contrive to concentrate the poison upon their surface and thus free the serum from it.

Such an argument cannot influence us, however, since the whole unorganized ferment or albuminoid theory is certainly one that deserves but little consideration, on the part of chemists and others trained in exact science.

I have considered this rather voluminous introduction necessary, to justify the course which I have taken to determine the relative effectiveness of disinfectants. Disinfectants are substances which destroy contagion, or, if we substitute for this bacteria, which destroy the life of bacteria.

In rendering bacteria lifeless, by the addition of disinfectants, two stages can be remarked: a limited quantity of disinfectants will render them motionless, in which state they do not multiply; a more abundant quantity, however, will produce death.

The effect of the disinfectant is often not an immediate one, and especially then if the quantity of disinfectant added is barely sufficient to produce the desired results.

Any substance added to a fluid to such an extent that the bacteria become merely motionless, has acted as an *antiseptic*. If the quantity of this substance, however, be increased to actually produce the death of these organisms, it has acted as a *disinfectant*.

Antiseptics are perhaps always also disinfectants, but their antiseptic and disinfecting action stand by no means in an invariable relation. It would, therefore, be absolutely wrong to deduce the disinfecting properties from the observed antiseptic action of these substances.

Rational methods proposed for the solution of the

question of the relative effectiveness of disinfectants require:

1. That the fluid containing the putrefaction and fermentation organisms shall be of as simple a composition as is consistent with the healthy development of these organisms.

2. After having been treated with various quantities of the disinfectants, the death of the bacteria must be proved by transferring them to a fluid well suited for their further development.

If dead, they will fail to further develop; if not destroyed, the further development of these organisms will prove this.

In order to comply with my first rule, it became necessary to select a fluid well adapted for the development of these microscopical organisms.

I had here the choice between Pasteur's liquid and Cohn's fluid.

The first contains in 100 parts: 10 parts sugar candy, 1 part ammonium tartrate, 0.5 part potassium phosphate.

The second contains in 100 parts: 1 part ammonium tartrate, 0.5 part potassium phosphate, 0.5 part magnesium sulphate, 0.05 part calcium phosphate.

For my first investigations I selected the latter, with the modification that I prepared it without the magnesium sulphate. I have since, however, come to the conclusion that this should not be done, though the bacteria seem to thrive even in this modified solution perfectly well.

Moreover I consider it a good plan to repeat the same experiment with either of the solutions proposed, to eliminate if possible the interference which may arise from the use of the fluids.

The next thing to be done was the stocking of this fluid with bacteria. This was performed by allowing a current of air, which had previously passed through a putrifying mixture of urine and fæces, to pass

through this liquid for twenty-four hours. The fluid becomes opalescent during this process and further standing for twenty-four hours aids considerably in the development of the bacteria.

After forty-eight hours this fluid was used for the purpose of studying the influence of the disinfectants upon the bacteria, which it contained.

The question arose now, how I should transfer the disinfected bacteria to pure fluid without the fear of seeing the results masked by outside interference.

The most direct plan of transferring the disinfected bacteria, by means of a pipette, I feared to use for two reasons. The solution necessarily comes again in contact with the outside air and may thus become contaminated; and furthermore, if the destruction or partial destruction of the bacteria should go hand in hand with a chemical combination of the disinfectants with the bacteria, it would be possible that so much of the disinfectant as would be sufficient for the demonstration of the antiseptic properties of the disinfectants, might be transferred to the new fluid. I therefore resorted again to the volatility—if I may be permitted to express myself so—of the bacteria, and I saw in this proceeding no harm inasmuch as others had stated, that even dead bacteria may thus be removed from the fluid in which they are contained.

Moreover, the preparation of the original fluid was in this case a perfect guarantee that the bacteria, which I had used, were thus readily transferable.

I must mention here, that this part of my method is, as far as I know, the only one that has thus far at least been assailed. Dr. Fischer, of Hanover, warns everybody against believing in my results, as Prof. Cohn has since found that bacteria may not thus be transmitted.

Now, unfortunately for Dr. Fischer, he has not only misinterpreted Dr. Cohn's casual statement, but he ignores entirely the fact that in my case the bacteria had been obtained in this way, which cannot be said of those

which were used by Cohn, and that perhaps there are a great many more species of bacteria than he is acquainted with.

Prof. Cohn mentioned this fact on occasion of publishing his results of the examination of air for germs of fungi, when he was astonished by the entire absence of bacterium development in the fluids through which the air had passed. He was even unsuccessful when the air had previously passed through a fluid containing bacteria. He leaves it undecided whether the development of the bacteria failed, for the reason that the rapid current of air carried off the bacteria, but failed to deposit them in the fluid destined for their development.

But might it not also be possible that the processes of development of fungi and of bacteria are fatal to the latter where the field is left to the strongest?

I am not prepared to clear up this doubt, but I will only mention that I have never failed to reverify my original results by the numerous experiments which were made for the purpose of control every time.

These experiments varied regarding their aim, as they were made as well to test the vitality of the bacteria on which new disinfectants were tried, as also to confirm the disinfecting properties of the original disinfectants and the reliability of my apparatus.

There is no doubt that bacteria may be carried off from the fluid in which they are expected to grow, and that only very few contribute to the propagation in my test fluid, yet I think they are not all thus removed; and if ever the rapid current of air will not allow their retention, the period of calm after the suction is discontinued, and which in my experiments ranges from two to eighteen days, should be sufficient to effect it.

The main features of this method, as I used it originally, may be found in an article on Salicylic acid, in the AMERICAN CHEMIST, August, 1875. My object

there was to determine the smallest quantities of disinfectants, which sufficed to render the bacteria lifeless. It is unnecessary to describe the apparatus again, but it might be of interest to show in how far I was able to guard against outside interference.

The flasks, which form a part of the apparatus, are first filled with alcohol and then dried in an air bath, at a temperature of between 120° and 130°C. The connecting glass tubes and rubber stoppers and connecting tubes are disinfected by immersion in strong alcohol for one hour, taking special precaution that the accumulation of air-bubbles in the tubes does not prevent the thorough contact of the alcohol with their entire surface.

The bottles which are to receive the pure test fluid (Cohn's) are then charged, and the fluid is boiled for several minutes. While this is in progress, the other bottles destined to receive the putrid fluid are taken from the air-bath and, while hot, charged with the required quantity of putrid fluid and the requisite quantity of disinfectant to be tested. The thinness of the glass of these flasks prevents the fluid itself from becoming heated to any deleterious extent during this operation. The flasks are then at once closed with the stopper containing the connecting tubes, and which up to this time had remained immersed in alcohol, but which was freed from it by violent jerking motion, so that only a trace, in the shape of a thin film covering the surface, remains at the time the connection is effected. The flask containing the boiling test fluid is then likewise closed, and the connection at once made.

The tubes filled with cotton are likewise disinfected by alcohol and heat. The suction, with the aid of a Bunsen filter-pump, is commenced in about a quarter of an hour, after the test fluid had sufficiently cooled to become a base for the further developments of the organisms contained in the other flask. Of the re-

sults which have since been obtained by the aid of this apparatus, I will mention:

1. Picric acid added to putrid fluid (slightly alkaline), in the proportion of 1 part to 200 pts. did not disinfect completely. If, however, the solution had been slightly acidified previous to the addition of the picric acid, a complete disinfection could be effected.

2. Hydrogen chloride completely disinfects if added to the fluid in the proportion of 1 pt. to 64 pts. The bacteria become during this process completely dissolved, and the formerly turbid fluid becomes perfectly clear.

This shows that our mineral acids are pretty good disinfectants, and I believe, that in many cases even our metallic salts owe much of their disinfecting properties to the ease with which they may part with their acid. This is especially the case with potassic bisulphate, but perhaps also the salts of aluminium. Perhaps the greater effectiveness of the iron sesquisalts as compared with the protosalts is also due to this circumstance.

But in many cases, no doubt, the metallic base must be credited with the bulk of effectiveness (mercury, etc.).

If we desire, therefore, to disinfect the contents of a privy vault, we can easily do so by adding muriatic acid until a little more than 1½ per cent. of free acid is contained in the mass. The quantity of acid must, however, be far larger, than if we should desire to make only a 1½ per cent. water solution, on account of the strongly alkaline reaction of the contents of the cesspool.

The reasons that we do not so, but prefer rather metallic salts, as copperas or iron chlorides, are two: In the first place, the free acid would set H_2S free in considerable quantities; and, secondly, the security of the cesspool walls requires the application of salts

rather than acids, which latter would dissolve or loosen the cement.

But the iron salts give us another advantage. I have frequently met with the popular notion that iron salts, if added to decaying substances, produce a rapid oxidation. This is certainly true, when used under such conditions that the air has ample access, but it is not true under conditions as they exist in cesspools. Here they act rather as absorbers of oxygen, they prevent the presence of free oxygen in the mass, and thus bring about one condition which ensures the extermination of bacterium life.

One of the most serious disadvantages of the method for the determination of the relative effectiveness of disinfectants, as described above, is the fact, that each determination takes a considerable time, and since quite a series of determinations are necessary to finally determine the accurate value of one disinfectant, results can be but slowly reached unless one should be in the possession of a large series of such apparatus.

I have thus come to consider the possibility of reaching the same results in a simpler manner. How I have tried to accomplish this I shall describe below, after I have said a few words on Bucholtz's experiments, which were published about one month after my first publication, and an abstract of which may be found in the AMERICAN CHEMIST, November, 1875.

Mr. Bucholtz has taken the road, which I consider unsafe. His method is exceedingly simple. He first determined the antiseptic properties of the substances. This is the most simple operation and it was carried out in the same manner as described by me in my former publication. Instead of using Cohn's fluid, he preferred Pasteur's.

A certain quantity of Pasteur's fluid was mixed with certain quantities of various disinfectants, and then

these mixtures were each infected with one drop of fluid.

These mixtures remained under observation for several weeks. Some of them would become turbid from the development of bacteria, others would remain clear, thus denoting that the amount of disinfectant applied was sufficient for the demonstration of the antiseptic properties of these substances.

While, according to my own experiments, I had found the minimum quantity of carbolic acid to be 1 in 725 parts, Bucholtz required 1 in 200 parts.

Though my fluid, after infection, had remained in a loosely covered bottle for more than eight months, it showed not the least development of bacteria, so that therefore not only the activity of the bacteria, which had originally been added, but also the activity of those which had occasion to enter the fluid thereafter, had been readily arrested.

The manipulations being the same, the difference of action must be found in the nature of the respective liquids (Cohn's and Pasteur's) or the nature of the bacteria, or in both of these circumstances combined.

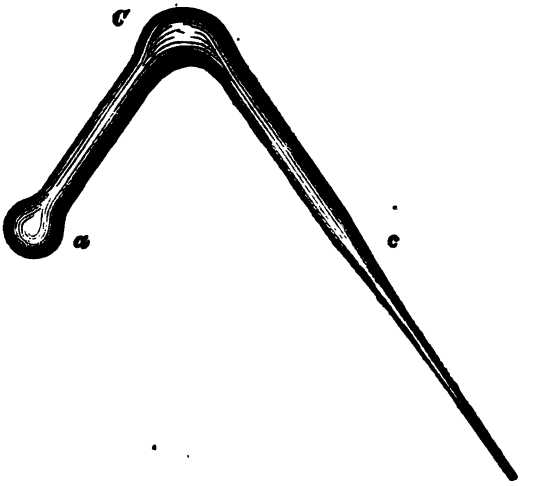
That the nature of the fluid can easily cause one to mistake substances which have neither antiseptic nor disinfecting properties for such as have, may be seen in the case of sodium salicylate, where the strongly acid reaction of Pasteur's fluid was the cause that Bucholtz enters this substance as an antiseptic.

For the determination of the disinfecting properties of substances, he collects by means of a pipette the antisepticized bacteria and transfers them to pure Pasteur's fluid, which is contained in a test tube, the mouth of which is closed by a stopper of carbolized cotton. Thus he ascertains the absence or presence of vitality in these organisms.

The reasons why the results thus obtained may be deceptive, I have stated above. I found that carbolic acid, for complete disinfection, must be contained in a

fluid in the proportion of 1 to 200 parts. Bucholtz states 1 to 25 parts, but he means here almost immediate effect, for he states that 1 in 100 parts would produce the same effect, if the action of carbolic acid was allowed to proceed for 50 minutes. From this it becomes evident how necessary it is for experiments of this class to be made on a uniform plan, so that the results of others can be easily utilized.

For the purpose of testing disinfectants which are non-volatile and do not absorb oxygen, I propose now to use the following plan.



My apparatus is a V-shaped glass tube which is at *C* widened to a little bulb for the purpose of having a larger volume of available air. Into the small bulb *a*, a solution, 1 pt. of Cohn's fluid with 1 pt. of water, is brought by slightly heating the apparatus, and then while it is cooling dipping the end *c*, which is drawn to a fine point, into the mixture until enough of the fluid has entered the wider part of the tube.

By proper inclination this may then be transferred to *a*. The bulb *a* is then heated until about one half of the fluid has passed off, when the remainder will have the concentration of normal Cohn's fluid.

While this process is going on, the point *c* passes into a test-tube, which is closed by a stopper of slightly carbolized cotton. The tube is then allowed to cool, while it remains in this position. It is evident that during the process it must fill with pure air, provided that the air in the test-tube is free from germs. To effect this, the test-tube had been previously partially filled with water, which was then boiled for several minutes while being closed with the cotton stopper.

While the cooling process of my V-shaped tubes —of which several may be passed at the same time through the cotton stopper—is going on, the mixture of putrid Cohn's fluid (first infusion), with various quantities of disinfectants, are prepared, and then a few drops of this mixture, which should be left standing for one hour, are made to enter at *c* in the same manner as described above for the filling in of Cohn's fluid; with the difference, however, that this fluid is suffered to remain at *c*. The tubes must be removed from the fluid, before the contraction of the air inside is completed. This becomes necessary, for the reason that the fluid shall have occasion to sufficiently recede from the under end of *c*, which is to be immediately closed before a flame.

If this precaution be not taken, the fluid itself might become so heated, that this alone, without the aid of disinfectants, might be sufficient to cause the death of the organisms.

These tubes can remain under observation for any length of time.

The circulation of the air inside can be promoted considerably by slight differences of temperature, to which the two shanks of the tube may be exposed.

The principle of this applicance is the same as that of the other, viz.: Determination of the possibility of infection from the air standing over a putrid fluid to which various quantities of disinfectants have been added.

A difference exists however in so far as in my first method I worked with a large excess and strong current of air, while here the amount of air is limited. As to results which may thus be obtained, I am not yet prepared to report.

The special points which are to be determined are as follows:

1. Is there any difference in the results which may be obtained by my original method and the one now proposed.

2. How are the results influenced by the use of Pasteur's and Cohn's fluid respectively.

3. How do the results obtained by the use of Pasteur's fluid with this method compare with Bucholtz's.

4. Action of disinfectants on different species of bacteria.

The experiments described above are founded on the belief that the bacteria themselves must be considered as the final cause of disease.

Whether they act now, as some physicians hold, mechanically, or whether the chemical changes which they produce in the constituents of the body impart or constitute disease, the action of substances, which we class as disinfectants, on the bacteria, remains of equal importance.

For practical application however it must be always considered, that it is not only the organic living mass, which comes in contact with the disinfectants, but many other substances, which, if they possess affinities for them, will partly form combinations which must occasionally destroy the efficacy of considerable quantities of the disinfectants.

In using disinfectants with the view of attaining

practical results, the quantities to be taken are governed by the composition of the material to be disinfected.

Our ordinary methods of disinfection seem to be fully equal to the demand, yet there are customs which I consider entirely unwarranted, if we compare them with the results of the described experiments. I refer here to the use of carbolic acid for the impregnation of the air in sick rooms.

The only good which I can see, as arising from this custom, is, that strangers, getting the smell of carbolic acid, will be on their guard, take the hint, and speedily leave the place.

For practical application, it may therefore be not entirely useless.

After I have now spoken on the manner and explained the methods, by which we might hope to arrive at definite results, it might appear, that perhaps nothing was more natural than to proceed in this manner, but looking over our literature one would be sadly disappointed. For the purpose of showing how various authors have tried to arrive at some conclusion regarding the value of disinfectants, I will add therefore a few words.

Fleck proposed in 1873 to ascertain the disinfecting properties of substances by ascertaining the reducing power on an alkaline silver solution, of a putrid fluid, which had been treated with various disinfectants.

Taking into consideration that perfectly harmless substances may thus reduce silver, it becomes evident that no value attaches to the results he obtained.

That he used an alkaline silver solution for the purpose of measuring the reducing power of the resulting fluids instead of a permanganate solution, which we use in water examinations, was perhaps due to his desire to have a method of his own. No doubt the permanganate test is of little value, as in no case does

it allow one to guess even at the quantity of the organic substance present, and less yet at its quality, unless another direct determination of the organic substance goes hand in hand with the first. Permanganic acid like chromic acid carries the oxidation under the circumstances here given, to a certain point only; the latter, for instance, may be boiled for several hours with pure diluted acetic acid, without giving up any of its oxygen.

Of a peculiar nature are Grace Calvert's publications. He invariably comes to the conclusion that there are no true antiseptics or disinfectants but carbolic acid and similar substances from the tar series, and his experiments seem all to be just fitted to the purpose of discrediting the disinfecting properties of almost everything else. In the first place, he has been very unlucky in the selection of the fluids which were to be disinfected: this in one case was starch paste; in another, albumen. Albumen I consider as the least suitable material, since it is a fact that it combines with almost all our disinfectants, and thus destroys to a great extent their efficacy, especially those of the metallic salts.

Secondly, his intention was not the determination of the disinfecting but rather the antiseptic properties of the various substances, and to this end he did not try to find the minimum quantity of the disinfectants which were required for the manifestation of this, but he used a minimum quantity, 1 : 1000, and noted the time when vegetable life appeared. The infection was to come from the outside air with which the contents of the open test-tubes were in constant communication. But how long under such circumstances can substances like sulphurous acid or ammonia be retained in the albumen solution? How long can soda or potash remain uncombined with carbonic acid? How long can sulphuric or nitric acid remain uncombined with ammonia?—especially if the appearance of fungi is

noted only after more than a fortnight. All these substances cannot produce lasting effects.

Moreover, his experiments prove, that the solution of albumen does not afford a good foundation for the growth of bacteria, that there is something wanting in the composition of this substance, so that the addition of certain substances helps to foster rather than to destroy the life of bacteria (nitric acid). While in pure albumen solution fungi appeared within eighteen days, and vibriones within twelve, after the addition of 1-1000 of nitric acid both appeared within ten days. We know very well that nitric acid is a disinfectant and antiseptic, but if we should make deductions from these results, we would come to the conclusion that nothing was less so.

From his results, I could give you numerous examples where, under these circumstances, it was folly to expect reliable results. That under these circumstances carbolic acid and cresylic acid, with their slight affinities for either bases or acids, and their high boiling points, which prevent loss by evaporation, must gain the prize is evident.

I do not deny that carbolic acid and the tar acids are true antiseptics and disinfectants, and that they stand at or near the head of the substances for which these properties are claimed; but I deny that the manner in which the experiments were made can give us a clue to the antiseptic properties of any of the rest.

And though he claims that none but carbolic acid, etc., are antiseptics, he has proved no more than that the quantities of the other antiseptics were not sufficient for the purpose of demonstrating their properties. Thus his investigations have no scientific bearing. They would have a practical end if the disinfectants had been applied in quantities representing the same market value.

I have to speak yet of a very remarkable series of

experiments by the same author. Meat is infected by the germs from the air; to protect meat, antiseptics are required. He now pours a layer of his antiseptic at the bottom of a wide flask, and then suspends pieces of meat on iron wires above them. The meat became sooner or later infected, and putrified, excepting in the cases where he had applied volatile antiseptics (carbolic and cresylic acids). In these cases the meat dried to a hard mass without showing even incipient putrefaction at any time.

How one could, under these circumstances, expect potassium, permanganate, chloralum, or zinc chloride to act, I cannot understand; yet this was done by Mr. Calvert.

I have been compelled to notice these papers, because they were considered as the most reliable investigations, and they have frequently been the foundation for statements and also experiments which were modeled according to the general principle, with, however, insignificant modifications.

While Calvert styled his results what they actually were, "Experiments to determine the efficacy of antiseptics," his followers went one step further and denominated their experiments as those intended to show the relative effectiveness of disinfectants.

Whether this was due to a want of properly understanding the difference of antiseptic and disinfecting action, or whether they were considered by these authors as standing always in a certain relation, I cannot decide.

That the latter is not the case becomes evident from Bucholtz's publication.

In urging this subject before the American Chemical Society, I have in view to lead scientific research in this direction, and at the same time to show how results may be obtained.

It is a peculiar fact, that this part of science, notwithstanding its importance, had so far at least not

the sympathy of the scientists, and this is certainly partly to be found in the backwardness of reliable botanical observations.

How sorely a revolution in this part of science is needed can easily be imagined by looking over our literature, even as far as 1875 (Th. Fischer, Abfallstoffe, etc.).

As to the propositions I have made, I may be wrong, and, if proved so, I am willing to acknowledge it. I did not intend and cannot put before you in this entirely new field positive truths as yet, but I desired to bring the plan before you, hear your opinions, and find coöperation in the large work before us.

IV.—On the Amalgamation of Iron and of Some Other Metals.

BY P. CASAMAJOR.

(Read June 1, 1876.)

At the last meeting of this Society I was to speak to you on amalgamation of iron, but was prevented by the lateness of the hour from reading the paper I had ready for you. Since that evening I have learned a great many things about iron amalgam, one of which is that most of the processes I was to describe had already been published, although in a very succinct form, about nineteen years ago. This discovery would have prevented me from appearing before you to-night, if I had not found that the subject is deemed by chemists, to whom I have shown samples of amalgamated iron, to be not only new but very interesting. I have, besides, much new matter to communicate, among which is a new process for amalgamating iron, which is so simple and economical that all the other processes are rendered obsolete and useless.

That iron will combine with mercury is known to

all chemists, although it is not deemed an easy operation, and we may find in the books several processes for accomplishing the combination. One of these, which I believe is due to Sir Humphry Davy, consists in immersing sodium amalgam in a saturated solution of ferrous chloride or sulphate. In another process zinc amalgam is brought in contact with iron filings in presence of a solution of ferric chloride. The filings become coated with mercury. In still another process the electrolysis of ferrous sulphate gives iron amalgam when the negative electrode is formed of mercury. By subjecting the resulting amalgam to enormous pressures, a residuum of pretty firm consistency is obtained, which is composed of about equal parts of iron and mercury.

The processes of amalgamation, which I am to describe to you this evening, give products which have nothing in common with these iron amalgams. The samples of iron amalgams, such as I have here, are obtained from commercial wrought iron, from cast iron, and from steel, without altering the original shape of the material, and are analogous to the amalgam made from commercial zinc, which we use in voltaic batteries. Before giving you the results of my labors, I must give you a succinct account of the researches of Cailletet, which came to my knowledge as follows:

Before presenting myself before you at the last regular meeting, it had been my endeavor to ascertain whether the results I was to announce were really new. Neither by my own exertions, nor by inquiry from other chemists, had I been able to discover that I had been forestalled, and, had I confined my attention to iron, I would not have been aware, perhaps, even now, of the existence of a prior claimant.

Having turned my attention to aluminium, I had occasion to consult Watts' Dictionary of Chemistry on the subject of aluminium amalgam, and came across the following:

"According to Cailletet (*Comptes Rendus*, vol. xliv., 1250), aluminium (also iron and platinum) may be superficially amalgamated by contact with ammonium or sodium amalgam and water, also when it is immersed in acidulated water in contact with metallic mercury, forming the negative electrode of a voltaic battery."

On consulting the 44th volume of *Comptes Rendus*, I found at p. 1250 a memoir presented to the Academy of Sciences by Messrs. Chevreul and Dumas, at the sitting of June 15th, 1857, the title of which is, *On the influence of nascent hydrogen on amalgamation*, by M. L. Cailletet.

The author uses ammonium amalgam, with which he agitates pieces of iron, aluminium or platinum, and he finds that these metals become coated with mercury. The amalgam of sodium produces the same effect, only water is necessary to the reaction. If the surface of the sodium amalgam is covered with *naphtha* no action takes place, but one drop of water is sufficient to produce the desired effect.

If in a vessel containing mercury and acidulated water, we place the electrodes of a battery, and, if the negative electrode be a piece of sheet iron in contact with mercury, the iron will be amalgamated as soon as hydrogen appears on this electrode.

From these experiments, Cailletet concludes that amalgamation, in these cases, is due to nascent hydrogen; and he seems, throughout his memoir, to be so intent upon proving this point, that every other circumstance is mentioned in the most cursory manner. We may be allowed to doubt whether, by covering sodium amalgam with naphtha, so that when iron comes in contact with the amalgam it is already covered with a film of naphtha, we have placed the iron in the best condition to combine it with mercury; and whether the non-combination under these circumstances is very conclusive of the necessity of nascent hydrogen

to determine the combination between iron and mercury.

The following experiment with a mercuric salt carries more weight with it. The author wishes to show that amalgamation, in the case of iron and platinum, is due to nascent hydrogen, and not to the electrical condition of the iron or platinum electrode. He takes the case of the electrolysis of salts of copper, silver, and mercury, and recalls that, at the negative electrode, we obtain metallic copper, silver, and mercury, but no hydrogen. If we have a salt of mercury subjected to a voltaic current, the negative electrode being made of iron or platinum, we may notice after awhile that globules of mercury appear on this electrode, but they show no tendency to combine with it. If now the electrodes are withdrawn from the mercury salt, and placed in a vessel holding acidulated water, as soon as the voltaic current passes, and hydrogen escapes at the negative electrode, the globules of mercury spread on this electrode, and it becomes amalgamated.

The above account of the memoir presented by Cailletet contains substantially everything there is in it. The circumstance mentioned in Watts' Dictionary, that the amalgamation obtained on iron and platinum is merely superficial does not appear, even by implication, in the original paper.

Amalgam of sodium, and ammonium, and the voltaic battery—these are the agents mentioned by Cailletet; these were also the agents that I used a month ago to determine the combination of iron with mercury. Although I now use a much simpler and a cheaper process, which I propose to describe in a few minutes, there are some points in connection with the alkaline amalgams, and with the action of the voltaic current, which may be studied with advantage.

Amalgam of potassium, which I first used for amalgamating iron, behaves in every way like amalgam of sodium; sodium, however behaves somewhat differ-

ently from potassium towards mercury, the combination with sodium taking place with greater violence, being accompanied by a flash of sodium light and the escape of alkaline vapors which are far from agreeable. These unpleasant manifestations may be reduced to a minimum by combining sodium at first with a very small quantity of mercury, a quantity not more than a fifth of the weight of the sodium. This gives rise to a violent reaction, but subsequent additions of mercury produce less and less effect, while, by bringing small pieces of sodium sucessively into a comparatively large mass of mercury, every fresh piece of sodium produces the same effect as its predecessor.

If the sodium amalgam has sodium enough in it to make it pasty, it will cover iron with a silvery coat.

This coat may be rubbed off, leaving the oxidized surface unaltered. If brought in contact with water, or, still better, with a solution of sal-ammoniac, the sodium amalgam is decomposed, and the mercury will sink into the iron. If the sodium amalgam is liquid, it will adhere in little drops all over the surface of a piece of iron shaken up in it; by the action of water, of acids, or of sal-ammoniac, the droplets will spread on the iron, which will become amalgamated.

Ammonium amalgam will give up its mercury to iron when rubbed up with it very persistently. Even then there are in every piece of iron, certain spots where the mercury will not adhere. The intervention of acidulated water, by decomposing ammonium amalgam with great energy, facilitates the amalgamation of iron in these difficult portions.

From the foregoing remarks, you will understand that the maximum of good effect may be obtained from a certain amount of sodium by the following method of procedure, while the combination of iron with mercury is very thorough and rapid.

We take four porcelain dishes and place them in a row, so that the piece of iron to be amalgamated may

be placed successively in each. The first dish contains a liquid sodium amalgam; the second, a solution of sal-ammoniac; the third, water acidulated with either sulphuric or hydrochloric acid; and the fourth, aqueduct water. The piece of iron to be amalgamated is taken up with tongs, and agitated in contact with the sodium amalgam of the first dish. This operation covers it with liquid mercury containing sodium amalgam. When the surface seems sufficiently coated, the iron is left for a few seconds in the solution of sal-ammoniac, on emerging from which, it is found covered with the curious and interesting compound which we call ammonium amalgam. The piece of iron is placed next in the acidulated water, and finally in aqueduct water to wash off the acid.

This series of operations is generally sufficient to leave a good coat of mercury on a piece of iron. If there should be spots left bare, a second series of immersions is generally sufficient to leave the surface perfectly covered. I need not say that the surface of the iron must be previously made clean by immersion in diluted acid.

By making the negative electrode of a voltaic battery of iron, and placing it in contact with mercury and with acidulated water, the iron will, after a time become amalgamated. I have obtained the same result by a single voltaic element, the positive plate of which is a piece of zinc, and the negative plate a piece of iron, one portion of which is in contact with mercury at the bottom of the cup, the exciting fluid being acidulated water. An addition of chloride of sodium to the liquid in the cup seems to hasten the reaction.

Iron may be amalgamated, also, by the use of zinc amalgam. This process gives the best results, and renders superfluous all the other processes we have mentioned. The use of zinc amalgam for the purpose had been attempted before, as, for instance, in the process I have mentioned where iron filings are rubbed

with zinc amalgam, in presence of a solution of ferric chloride, the reaction being assisted by heat. I also find in Watts' Dictionary that "According to Aikin, iron amalgam is formed by the action of zinc amalgam on ferrous chloride." No particulars are given about this process, but the results must have been, to say the least, difficult to obtain, as we find immediately after, that, "according to Damour, it cannot be obtained in this way."

I came upon the process I am about to describe by a mere chance. I was trying to test the soundness of the theory of Cailletet which attributes the amalgamation of iron to the presence of nascent hydrogen. In a beaker glass I had placed mercury, and, over it, acidulated water, and, also, a horse-shoe nail of Norway iron, which rested on the mercury. A moderate escape of hydrogen took place from the surface of the iron nail, but, after twenty-four hours, no trace of amalgamation had appeared, which showed very conclusively that unassisted nascent hydrogen was certainly not sufficient to do the work. Having to amalgamate a small piece of zinc for another experiment, I found that I had no other mercury within my reach than the one on which the nail of Norway iron rested. As I had given up hopes of accomplishing anything by this arrangement, I had no scruple to use the mercury in this beaker glass, and in it I placed my piece of zinc. The result was that the escape of hydrogen from the nail increased very perceptibly, which circumstance induced me to leave the zinc in the mercury. On looking again at the nail, I found it amalgamated, and partly sunk into the mercury.

To amalgamate iron with zinc amalgam, mercury should be placed in a vessel and covered with dilute sulphuric or hydrochloric acid. If now a piece of iron is agitated, in contact with the mercury and the acid, no combination will take place, but if pieces of

zinc are placed in the mercury, in a few minutes, iron placed in the above conditions will become coated with mercury. If, after a while, the power of the mercury seems to decline, more zinc must be added. The zinc is only attacked when iron, or some other metal more electro-negative than zinc, is brought in contact with the zinc amalgam and the acid, so that the expense in zinc is very slight.

The coat of mercury left on iron by the various agencies I have mentioned is not a superficial layer, for the mercury sinks into the metal, modifying its physical and chemical properties. In the case of pure, soft iron, it is difficult to notice any decrease of tenacity after amalgamation. With hard tempered steel, however, the increased brittleness is very marked. In the case both of iron and steel, a fresh fracture shows that mercury has penetrated deeply into the metal.

Of the chemical change operated on iron by amalgamation, I can call attention to only one point, which is the analogy which exists with the properties of zinc amalgam. When a piece of zinc* has been amalgamated, it is not attacked by acids as readily as zinc free from mercury, but if a piece of amalgamated zinc is connected to a piece not amalgamated, the amalgamated zinc becomes the positive plate in a voltaic couple. These properties of amalgamated zinc are found, although in a less degree, in amalgamated iron. Two pieces of sheet iron, presenting exactly the same surface, were placed in diluted sulphuric acid, so that the action of the acid was exactly the same on each. One of these plates was amalgamated, the other not. After prolonging the action for over two hours, it was found that the amalgamated plate had lost two-thirds as much in weight as the other.

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* This observation relates to impure zinc. Amalgamation makes impure zinc behave towards acids like pure zinc.

This is more easily noticed with steel than pure, soft iron.

If, however, two pieces of iron, one amalgamated and the other not, are connected by a metallic wire, the amalgamated plate is attacked, and the other plate plays the part of a negative.

In iron amalgam made in the way I have described, the quantity of mercury in combination is very small. A piece of sheet iron presenting on both sides a total surface of three square inches, was amalgamated and left to soak in mercury for over an hour. The mercury was then wiped off very thoroughly and the piece of sheet iron weighed. The increase over the original weight was 13 centigrammes, which showed an absorption of mercury equal to a little over 4 centigrammes per square inch. The increase of weight in this thin sheet of iron was only 3¼ per cent. Still in this sheet the fracture was silvery and globules of mercury stood on the rough edge of the fracture.

For the sake of comparison, I treated a piece of sheet zinc of the same dimensions in the same manner, leaving it, however, only a few minutes in contact with mercury. After rubbing off the excess of mercury and weighing, I was surprised to find a loss instead of a gain in weight. This was doubtless due to a certain quantity of zinc being dissolved by the mercury.

I must now, to fulfil the programme offered by the title of this paper, speak to you of the amalgamation of some other metals, by which are meant some of those whose point of fusion is very high and which have always shown themselves exceedingly adverse to combining with mercury. Those that I have tried are platinum, palladium, aluminium, nickel, and cobalt. Except in the case of aluminium, there seems nothing of peculiar interest to notice about their amalgams after what has been said of iron amalgam. These metals all take mercury very readily by the processes

which are effective in the case of iron. Aluminium deserves mention on account of its eccentric behavior. It seems to take mercury in the same manner as the other metals, but shortly after being taken out and dried it becomes very hot, the mercury seems to boil and the aluminium remains covered with a chalky crust. On brushing this off the metal is found beneath without a sign of amalgamation.

In conclusion, I will point out that two inquiries suggest themselves in connection with these amalgams. One relates to the determining cause of these combinations, and the other is whether these amalgams, particularly amalgam of iron, can be applied to useful purposes. To both these questions the answer is that I have nothing satisfactory to offer, although great many things suggests themselves as plausible. I am sure you will readily excuse me from presenting theories that are merely plausible, as to the cause of these phenomena, and feel equally certain that I need offer no apology to this enlightened auditory for calling their attention to these combinations of mercury with iron and other metals because these have not yet become of practical utility, although it may be befitting to offer an apology for the manner in which the task has been performed.

V.—On the General Occurrence of Vanadium in American Magnetites.

BY ISIDOR WALZ, PH.D.

(Read June 1, 1876.)

A search of chemical literature shows but very few recorded observations of the occurrence of vanadium in this country. Teschemacher * found vanadic acid in crusts covering the native copper at Lake Superior, and Dr. A. A. Hayes † proved that vanadium

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* Am. Journ. Sci. II., xi. 223.

† Proceedings Amer. Acad. (Boston), Jan. 12, 1875.

was widely distributed, occurring generally, though but in minute quantities, in porphyritic and slate rocks, natural waters, etc. In the paper cited he confirms the correctness of Teschemacher's observation, and also alludes incidentally to a brown *ferric and cupric ore*, occurring in a chalcedonic rock in the Tinctic district, Utah, in which vanadium was found. I learn by a private communication from Prof. G. A. Koenig, Ph.D., of Philadelphia, that last fall he announced to the Philadelphia Academy of Sciences, in a preliminary communication, that he had found vanadium in schorlamite, perowskite and a number of minerals from Magnet Cove, Ark., among which there was also a magnetic iron ore. This communication has not yet appeared in print. Prof. F. A. Genth is also about to publish the analyses and descriptions of two new vanadium minerals from California. The above-mentioned observations are all that I have been able to find, bearing on the occurrence, in this country, of vanadium in general, and in iron ores more particularly.

The facts which I am about to communicate seem to prove that one very general occurrence of vanadium in this country has hitherto been entirely overlooked, namely, that in magnetic iron ores, in which it exists sometimes in quantities which are not inconsiderable in view of the generally assumed sparse distribution of this element.

As one of the reasons why it has been overlooked is perhaps to be found in the not very simple methods proposed and in use for the demonstration and estimation of vanadium, I beg leave to submit, first, the method which I resorted to, and which gives positive results even when only very minute quantities are present.

QUALITATIVE EXAMINATION.

One gramme of the finely-powdered and bolted ore is fused in a porcelain crucible with 6 grms. of a

mixture of equal parts of anhydrous sodium carbonate and sulphur. The fused mass is treated with water and filtered, and the filtrate acidulated with hydrochloric acid. According to the quantity of sulphide of vanadium present, the sulphur precipitate is of a light to very dark chocolate color; but even if it is not discolored it will be advisable to continue the examination. The precipitate is allowed to settle and filter through the smallest possible filter of the best quality of Swedish filtering paper; the precipitate is washed, dried at 100° C., the sulphur extracted by means of carbon disulphide, and the filter dried again. After the treatment with carbon disulphide, a dark residue of vanadium sulphide is in nearly all cases left on the filter, and it is generally contaminated by minute quantities of titanic acid, when the ore is titaniferous, and of silica. The dried filter is taken out of the funnel, spread out, and every part to which no precipitate adheres is cut away with the scissors; all the vanadium sulphide that can be detached is collected in a very small porcelain crucible, and the rest burned, with the filter, in a platinum spiral. The vanadium sulphide is thus oxidized to vanadic acid, and care should be taken not to allow the mass to fuse on to the platinum wire. The filter ashes are subdivided into about four equal parts, two of which are used for the blowpipe reactions (phosphate and borax bead). The titanic and silicic acids present sometimes interfere with the distinctness of the blowpipe tests, though generally I obtained quite satisfactory results. In case the quantity of vanadium sulphide was too minute to have allowed of detaching any from the filter, a third portion of the filter ash is placed in a small, white porcelain dish (such as painters use are very convenient), and treated with a drop of conc. sulphuric or hydrochloric acid, free from iron. If vanadium is present, it will be dissolved with an orange to a reddish-brown color, which in

case of hydrochloric acid soon changes to a greenish yellow. A few drops of water, about one c.c., are added till the solution is colorless, and then from one to three drops of a solution of potassium ferrocyanide, which must be so dilute that three to five drops will only impart a faint, yellowish tint to a c.c. of water. If vanadium is present a fine green coloration will be produced, which, together with the other indications obtained before, may be considered as conclusive evidence of the presence of vanadium.

The vanadium sulphide which had been detached from the filter and transferred to the tiny porcelain crucible, is ignited under access of air, till the vanadic acid, formed by oxidation, is fused. On cooling, the peculiar color and crystalline texture of vanadic acid may be noted with the aid of a lens. It is then dissolved in acid as above, diluted and tested with potassium ferrocyanide, which reaction I find to be unexpectedly delicate. During the whole qualitative examination, acid, water and the other reagents should be used only in the smallest possible quantities, especially when dealing with mere traces of vanadium.

QUANTITATIVE DETERMINATION OF VANADIUM.

For quantitative analysis 5 to 15 grammes of the ore are taken and treated precisely as above, till the vanadium sulphide is obtained on the filter tolerably pure. It is ignited in a platinum crucible, and the filter ashes deducted from the weight of the vanadic acid (v). The latter is fused with a little sodium carbonate, dissolved in cold water and filtered. The sodium titanate remaining on the filter is weighed, and the weight of the titanic acid (t) calculated from it. The solution of sodium vanadate is acidulated with nitric acid, evaporated to dryness, dissolved in water and filtered. The silicic acid remaining on the filter is determined and its weight (s), plus (t) deducted from v. The weight v—(t + s) represents very closely the

exact quantity of vanadic acid contained in the ore. I believe this method to be not only much simpler, but quite as correct as that which for brevity's sake, I will call the ammonium-vanadate process.

OCCURRENCE OF VANADIUM IN AMERICAN MAGNETITES.

My attention was first directed to the subject about three months ago, while I was engaged in the partial analysis of specimens of the highly titaniferous magnetic iron ore from the Church mine, near Van Sickles' corner, N. J. The results of these determinations were as follows, the numbers 1, 2, 3, and 4, designating samples taken from near the two walls, the middle, and the bottom of the mine respectively:

	No. 1.	No. 2.	No. 3.	No. 4.
Titanic Acid.....	14.45	12.19	9.82	13.30
Phosphoric Acid...	0.007	——	——	trace
Vanadic Acid.....	0.31	0.38	0.36	0.41
Sulphur.....	0.485	——	——	——
Fe.....	55.02	——	——	54.04

Another ore from a mine very near the same locality (No. 5) gave the following results:

	No. 5.
Titanic Acid.....	12.02
Phosphoric Acid.....	0.158
Vanadic Acid.....	0.13

Externally there was nothing to distinguish these ores from many other magnetic iron ores, which had come under my observation; they present compact masses, of a lustrous fracture, and interspersed with gangue of a greenish color, resembling serpentine or epidote.

As it was a mere accident to which I owed the finding of vanadium in these ores, the suspicion arose that the occurrence of vanadium in magnetites might be general, and I determined to extend the investigation to magnetites of different varieties and various localities. Through the kindness of Profs. Drs. R.

W. Raymond, H. C. Bolton, P. Schweitzer, E. A. Smith, and especially of Prof. J. S. Newberry, I was enabled to collect and examine the following specimens. The preponderance of New Jersey ores is due to the fact that my first intention was to confine myself to ores from that State alone:

No. 6. Magnetite from Peters Mine, Ringwood, N. J.

No. 7. " " Snyder Mine, " "

No. 8. " " Milligan Mine, " "

No. 9. " " Green Powder Mine, Copper Vein, near Boonton, N. J.

No. 10. Magnetite from Orchard Mine, N. J.

No. 11. " " Ogden Mine, Franklin N. J.

No. 12. " " Split Rock Mine, Middle Shaft, Boonton, N. J.

No. 13. Magnetite from Essex & Champlain Mining Co., N. Y.

No. 14. " " Port Henry, Iron Ore Co., N. Y.

No. 15. " " Franconia, N. H. (this specimen consisted to more than half its weight of epidote).

No. 16. Magnetite from Codorus Steel Co., York Co., Pa.

No. 17. " " Cranberry Mine, N. C.

No. 18. " " Cane Bed Mine, Marmora, Canada West.

No. 19. " " North Crosby, Canada.

No. 20. Titaniferous Magnetic Sand, Long Island, N. Y.

No. 21. Hercynite from Westchester Co., N. Y.*

No. 22. Magnetic Sand, Lower Cal.

No. 23. Magnetite (Chuckwater Ore) from near the Black Hills, Dacotah.

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* See analysis by Dr. J. P. Kimball, AMER. CHEMIST, IV., 321.

No. 24. Magnetite from Cornwall, Pa.
No. 25. " " Kennedy's, Clay Co., Ala.
No. 26. " " Odin's Mill, Talladega Co., Ala.
No. 27. Titaniferous Iron Sand from Moisie, Canada.

No vanadium was found in No. 9; the minute residue on the filter proved to be copper sulphide. Possibly the copper reactions prevented the recognition of a trace of vanadium that may have been present.

In No. 10, the trace of sulphide obtained was so minute that it was impossible to obtain a positive result.

In all the other ores examined, I was able to establish the presence of vanadium beyond doubt, in quantities ranging from distinct traces to 0.31 per cent. vanadic acid in No. 19. Although I have made but two other quantitative determinations—one in No. 6, 0.16 per cent. vanadic acid—yet, as I weighed off exactly 1 grm. of ore for each test, and treated all samples exactly alike, I believe I have some basis for the following estimations. In No. 20 (magnetic sand from Long Island) I found 0.1 per cent. vanadic acid, and Nos. 22 and 27 contain about the same quantity. Nos. 13 and 14, of a class of ores reputed singularly pure, contain not much less, being about on a par with 23 and 25. Nos. 10, 15, 16, 17, 21, 24, and 26 contain but little more than traces.

In view of these facts, and of the wide range of localities covered by the specimens examined, I believe it may safely be asserted that vanadium is a general constituent of American magnetites, and it would seem to be desirable that, in future, chemists take account of it in the analyses of these ores. Metallurgists, also, would undoubtedly do well to study the influence of vanadium on iron more closely.*

* I am inclined to believe that the presence of vanadium in iron is beneficial; Swedish iron, noted for its excellence, contains it frequently.

In Europe, vanadium has been found to be very widely though also very sparingly distributed in iron ores, especially the secondary ones, limonites, hematites, sphero-siderites, bog-ores, etc.; and as it is now proved to occur generally in our primary ores, it is probable that, if looked for, it will be found in corresponding American ores also. I regret that want of time forbids me to examine these also, and I hope that this part of the subject will be taken up by some one else.

In the course of this investigation, I could not fail to notice a close association between titanic and vanadic acids, the ores containing the former being generally richer in vanadic acid than those that contain little or no titanic acid; and I believe that the presence of titanic acid is a good indication of vanadic acid. I believe I do not violate any confidence in stating that Prof. Koenig arrived independently at the same conclusion; and the publication of his researches on the minerals of Magnet Cove will no doubt throw further light upon this point. Some of the recorded analyses of European minerals seem to confirm this view. Th. Engelbach* found titanic and vanadic acids associated in the trachydolerite and nephelinodolerite, near the Vogelsberg; C. Huber, † in psilomelane, from the Krakow mine, near Katzenellenbogen; R. Apjohn, ‡ in trap rock from Dunamoe, County Wicklow, from the Giant's Causeway, and from Vincentine, in Italy; and R. J. Hodges, § in the iron ores in the northern part of the County of Antrim.

Recently, a manufacturer mentioned to me the fact that he had lately obtained an iron of unusual tenacity and resistance to strains; and, on inquiry, I found that the ore was from the Musconetcong range, N. J., the same range from which the specimens Nos. 1–5 were obtained.

* Jahresber. 1860, 810.
† *Ib.* 1863, 861.
‡ Chem. News, 26, 183.
§ *Ib.* 26, 288.

VI.—Action of Impure Rain-water on Lead Pipes.

BY PAUL SCHWEITZER, PH.D.,
of the University of Missouri.

(Read June 1, 1876.)

The Laboratory of the University is supplied with rain-water, which collects in a tank in the upper part of the Scientific Building, and is carried to the working tables of the students by lead pipes, which are furnished with brass stop-cocks. In using this water for ordinary analytical work, as for instance, saturating it with sulph-hydric acid, it was soon found to be unfit for such purposes, on account of the quantity of metals it had dissolved, after standing in the pipes for only a short time. It is a well-known fact that pure water attacks lead much faster than water containing a certain quantity of mineral salts, and this seems to be also the case with rain-water, which contains invariably ammonia, nitrous and nitric acid; some sulphuric acid was also found in this water, derived from the smoke and cinders which fall on the roof of the building from the coal fires that heat the rooms. The following quantities of metals were found in one U. S. gallon of 231 cubic inches of the filtered water, that had stood in the pipes for one month:

1.079	grains	metallic	zinc.
0.537	"	"	iron.
2.503	"	"	lead.
0.082	"	"	copper.
0.049	"	"	arsenic.
4.250	grains.		

Arsenic, copper, and probably iron, are derived from the lead pipe, manufactured from an inferior quality of lead, and zinc from the lining of the tank. In supplying private houses or institutions with water through a system of pipes, care should be taken to find out whether the water to be supplied be pure or

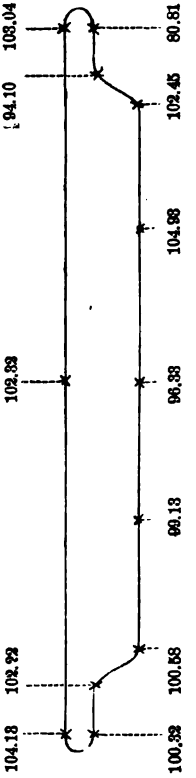
not; in the former case, and when rain-water is the source of supply, as it is in many sections of our State, lead pipes should be discarded, and tin-lined lead pipes substituted for them.

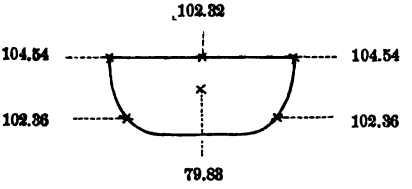
VII.—On the Cause of Discrepancies in the Estimation of Silver in Pig Lead.

BY PAUL SCHWEITZER, PH.D.

(Read June 1, 1876.)

I had occasion, some years since, to determine the silver in a lot of bullion lead from one of the Western States, and took two samples for this purpose from a kettle which contained about ten tons of melted metal. The mean of the two essays indicated 81.62 ounces of silver, inclusive of 0.36 ounces of gold, to the ton of lead, while other parties who assayed it at the same time, but took their samples from one or more slabs cut out of the middle of the pigs, reported somewhat less. Thinking it not at all unlikely that there might be a difference in the composition of the metal derived from different parts of the pig, I cupelled seventeen samples, each weighing about fifteen grammes, and taken from a pig of about eighty-five pounds in weight, under as nearly uniform conditions as I could obtain, and found figures which clearly prove the existence of such difference. The silver collects in larger quantity on the outside than in the interior of the pig, in greater proportion on the upper than on the lower side, and in fact more in all those parts which solidify before the rest of the metal, which contains then correspondingly less. I give the figures without further comment, only stating that they indicate ounces of silver to the ton of lead, and that the samples were taken from the spots marked opposite to them in the following diagram:


103.04
94.10
102.33
102.92
104.18
80.61
102.45
104.93
96.33
99.13
100.58
100.32


102.32
104.54
104.54
102.36
102.36
79.88

Complete analysis of lead used in this investigation

Ag	= 0.8215	p. c.	(98.77 oz. to ton.)
Cu	= 0.8317	"	
Bi	= 0.0679	"	
Sb	= 0.0021	"	
Su	= 0.0012	"	
As	= trace.		
Fe	= 0.0085	"	
Zn	= 0.0006	"	
Pb	= 98.7665	"	(by loss.)
	100.0000		

VIII.—Analysis of the Gneiss of Manhattan Island.

BY PAUL SCHWEITZER, PH.D.

(Read June 1, 1876.)

In a paper published in the American Chemist for June, 1874, I gave a description of the stratification and occurrence of the Gneiss-rock of the north-eastern portion of Manhattan Island, and analyses of the various constituents of it, where they occurred in large enough masses to be separated from each other. I collected at the same time samples of Gneiss, of which I analyzed that variety which exhibits the most perfect stratification, and which consists of small-grained minerals of about the same size, well mixed, and appearing parallel to the strata-like mica and vertical to them, like well-defined seams of quartz, feldspatic matter and mica.

Its composition is almost identical with that of a Gneiss mentioned by Bishop,* which illustrates by comparison its formation from argillaceous slate and its conversion into micaceous or quartzose schist; the distribution throughout its mass of small particles

* Lehrbuch der Chemischen und Physikalischen Geologie, Vol. III., p. 245.

of iron pyrites accounts sufficiently for the rapidity, with which it weathers and breaks up into grains of larger or smaller size.

57.20	SiO_2
19.51	Al_2O_3
9.52	Fe_2O_3
0.59	Fe
0.07	S
4.40	MgO
5.73	CaO
0.28	K_2O
2·13	Na_2O
0.48	loss by ignition
100.51	

Strong boiling hydrochloric acid dissolved of it 9.99 p.c. and caustic potash 3.74 p.c.

IX.—Bismuth in Lead in the Manufacture of White Lead.

H. ENDEMANN, PH.D.

(Read June 1, 1876.)

In the manufacture of white lead Bismuth is regarded as a valuable constituent of the lead, used for this purpose. Nevada lead is known as one of the leads, which are produced in this country, for always containing some bismuth, and in the ordinary Dutch process of preparing white lead this metal undergoes readily the oxidizing process, if it is intimately mixed with the lead. Yet it occasionally happens that the bismuth concentrates at certain parts of the bugles, which are cast previously to the process of oxidizing, and then it resists oxidation for a considerable time.

It frequently happens that bugles are found which appear but partly oxidized, and as they as a rule part in the middle, the fracture appears with a black coating. Experiments proved that this black coating was oxidized, when under the influence of oxygen, car-

bonic acid and acetic acid. The process is, however, a very slow one. I therefore collected some of the black material by scraping it off and removing the adherent white lead by means of diluted acetic acid. Thus a black crystalline powder was obtained, which easily dissolved in nitric acid. The nearly neutral solution was decomposed on the addition of water. No precipitate was obtained with sulphuric acid. On testing it further by means of Bunsen's flame reactions, it was ascertained, that the substance was pure Bismuth.

The question, why this concentration of bismuth only occasionally occurs, has not yet been determined experimentally, but I attribute it to the temperature of the lead at time of the casting of the bugles. If the temperature be comparatively low, the solidification of the bugles is an almost instantaneous one. If, however, perhaps towards the end of the operation of casting, the supply of molten lead decreases, this becomes overheated and remains, though solid outside, sufficiently fluid on the inside to allow the bismuth-lead alloy, which has a very low smelting point, to concentrate in the interior.

The question is to be further investigated.

X.—Kerosene Oil.

BY H. B. CORNWALL.

(Read June 1, 1876.)

The following experiments were begun with the view of ascertaining how much less yield might be expected from petroleum when making a kerosene flashing at 100° F. than when making one flashing at 86° F. Dr. Chandler, in his valuable Report on Petroleum, presented to the Board of Health of New York City, and published in the American Chemist, has given as the mean of seventy-five oils flashing below 100° F., an average flashing point of 86.6°, and a burning point of 107°. Among twenty specimens

tested lately, I was fortunate enough to find one, No. 1, Table I., representing an average oil, in respect to its flashing and burning points, although its specific gravity, 49° Beaumé, was much above the average of 47° B., given by Dr. Chandler. Table I. contains a list of the oils experimented upon; the time employed in making the flashing test, and the time consumed in raising the oil after flashing to the temperature (Fahrenheit) at which it took fire from the ignited gases and continued to burn, being given in minutes, in the third and fifth columns. The tests were made in Tagliabue's open tester, with a detached screen; stirring the oil before applying the small gas flame, used to ignite the escaping vapors. The specific gravities throughout the experiments were taken at 60° F., with a bulb tube holding 3.505 grammes of distilled water, and were reduced to degrees of Beaumé's hydrometer by Gilpin's formula, as given in Johnson's Cyclopædia, vol. ii.; specific gravity $= {}_{1}\frac{144}{34+x}$; x denoting the degrees Beaumé. It should be remarked that the results obtained by this formula are about one-half of a degree lower than those given by Fownes on the authority of Francœur.

TABLE I.

Number.	Specific Gravity, B.	Time.	Flashing Point.	Time.	Burning Point.
1	49.7	21	86	7	107
2	——	25	96	8	112
3	48.7	——	110	—	124
4	47.1	15	80	7	100
5	45.3	23	121	5	138
6	——	12	98	5	113
7	50.4	23	118	6	135
8	45.8	12	104	5	125
9	——	28	104	5	120
10	——	23	81	—	——

The following experiments were made with the above oils:

I. A glass flask containing 200 c.c. of No. 1 was heated over a spirit-lamp. Through the cork of the flask passed a thermometer and also a tube, which was connected with narrow glass tubing, surrounded with ice for a distance of about four feet, to condense the vapors. At about 90° C. bubbles of gas began to rise, and at 150° C. liquid began to flow from the condenser. After collecting 8 c.c. of this distillate, the operation was stopped, and the cooled oil in the flask found to measure 191.8 c.c. When tested it gave the result indicated by No. 2, Table I.; the flashing point had been raised 2.5° F., and the burning point 1.25° for each per cent. of distillate.

II. On treating 150 c.c. of the same oil, No. 1 (all that was left), in a similar way, the bubbles of gas began to rise as before at 90° C; at 150° to 155° the condensed distillate began to flow, and 4.25 c.c. were obtained, having a specific gravity of .727=64° B.; at 155° to 165° C. I collected 11.5 c.c. of liquid having a specific gravity of .746=59° B. The residual oil, No. 3, was little darker than the original oil. It measured 184 c.c., so that about 10.6 per cent. had been removed. The results show that the flashing point had been raised 2.27° F., and the burning point 1.6° for each per cent. driven off. It must be stated that this burning point is not very reliable, having been determined with a very small quantity of the oil, because the greater part was removed immediately after the flashing test, for Experiment III.

III. After determining the flashing point of No. 3, it was at once removed from the tester and cooled quickly, and then shaken up with 10.6 per cent. of a mixture of the two distillates of Experiment II. in the proportions there given, viz., 4.25 : 11.25; the mixture having a specific gravity of .743=59.8° B. The oil flashed at 89° F., and burned at 107°; almost its original condition. (See also Experiment VII.)

IV. A worse oil was next treated, No. 4; 220 c.c. being heated until 22 c.c. of the distillate had been collected. The first 5.5 c.c., collected at 150° to 155° C., had a specific gravity of .729=63.5° B.; the last 11 c.c., ending at 175° C., had a specific gravity of .738=61.1° B. The intervening 5.5 c.c. of distillate was not tested for specific gravity.

On measuring the residual oil it was found that 2.7 per cent. of it was not accounted for by the amount of distillate collected. The resulting oil, No. 5, Table I., was very dark. As the tests show, it had been rendered very safe; the flashing point being raised 3.2° F., and the burning point 3° for each per cent. driven off (12.7 per cent. in all). This increased improvement was very probably due to the expulsion of a small proportion of very light naphthas, not easily condensed. (See oil No. 7, in Table II.)

V. After collecting only 5 c.c. of distillate from 200 c.c. of the same oil, No. 4, I obtained a discolored oil, which I purified by treatment with sulphuric acid and caustic soda, obtaining No. 6, Table I.; the flashing point having been raised 3.6° F., and the burning point 2.3° for each per cent. of distillate collected.

VI. I next tried the effect of adding naphthas (and benzines) of different specific gravities, with the results given in Table II., in which I have inserted the results obtained by Dr. C. B. White, of the New Orleans Board of Health, and given in Dr. Chandler's report. The naphtha employed by Dr. White must have been a light one, lighter than those I obtained by distilling kerosene. The results in Table II. are very interesting, when the specific gravities of the naphthas there employed are compared with those obtained in the preceding experiments. It may be here stated, that, strictly speaking, the commercial naphtha has generally a specific gravity of 70° to 76° B.; the hydrocarbons of 62° to 65° B. being technically called *benzine*.

In Table II. I have given the average difference of the flashing and burning points for each per cent. of naphtha added, keeping the time of the tests as nearly the same as possible.

TABLE II.

Oils.	Flashing Point.	Difference.	Burning Point.	Difference.
No. 7, Table I., alone	118	..	135	..
" " + 1% N. of 65° B.	112	6	129	6.
" " + 3 " "	103	5	123	4
" " + 5 " "	96	4.4	116	3.8
" " + 10 " "	83	3.5	102	3.3
" " + 1% N. of 71.7° B.	107	11	133	2
" " + 5 " "	Below 70	..	105	6
No. 8, Table I., alone	104	..	125	..
" " + 2% N. of 65° B.	96	4	120	2.5
" " + 10 " "	76	2.8	107	1.8
Dr. White's Oil alone	113	..	..	..
" " + 1% Naphtha	103	10	..	..
" " + 2 "	92	10.5	..	..
" " + 5 "	83	6	.	..
" " + 10 "	59	5.4	..	..
" " + 20 "	..	..	50	..

VII. The circumstances of Experiment III. led me to make the following experiments on different oils: I determined the flashing point of the oil carefully, then poured it at once from the tester into a glass vessel, and allowed it to cool to the temperature of the laboratory, about 70° Fahrenheit, after which I again determined the flashing point. The time in minutes for making each test is given in the following table, with the difference in degrees of Fahrenheit between the two flashing points. The results are so different from those of Mr. Grace Calvert (*Chemical News*, American Reprint, May, 1870), that I have deemed them worthy of publication, he having obtained differences nearly or quite twice as great.

TABLE III.

Oils.	Time.	Flashing Point.	Time.	Flashing Point.	Difference.
Oil No. 9, Table I.	26	105	19	109	4
" 7, "	18	118	24	121	3
" 10, "	23	81	32	84	3

VIII. Dr. Chandler has shown in his report that when the temperature of a room is 82° to 84° F., the oil in glass lamps may easily reach a temperature of 90° F., and in metal lamps of 104° F. (and in an exceptional case 120° F.) after burning one or two hours; the average for thirteen metal lamps being 96¼° F. and for thirteen glass lamps 86° F. for four hours. With the temperature of the room at 90° to 92° F., the average for the metal lamps was 104¼° F., and for the glass lamps 92¼° F., the highest temperature observed in a glass lamp being 98° F. Probably the greatest danger from kerosene lamps arises from the risk of overturning and breaking the lamp, although undoubtedly explosions sometimes break lamps, and I therefore tried some experiments to ascertain the probable behavior of different oils when a lighted lamp was broken. Thin glass flasks containing 200 c.c. of the oils were provided with corks, through which passed glass tubes holding wicks. The oil in each flask was then heated in a water bath to 95° F., and the wick lighted, after which the flask was dropped upon a brick floor near a steam boiler, the bricks having a temperature of about 93° F. The results are given in Table IV. No. 8 was a mixture of No. 1 with 5 per cent. of naphtha of 65° B., and No. 9 of No. 1 with 5 per cent. of naphtha of 71.7° B.; the others, like all of the oils in this article, were bought from dealers.

TABLE IV.

Number.	Flashing Point.	Burning Point.	Remarks.
1	118	135	The wick continued to burn quietly without igniting the spilled oil.
2	104	120	Like No. 1.
3	100	112	" " "
4	98	116	Part of the oil was slowly ignited.
5	96	111	All of the oil at once took fire.
6	80	100	Like No. 5.
7	80	98	" " "
8	96	116	" " "
9	Below 70	105	Ignited with a flash.

Oil No. 7 of Table IV. was the cause of an accident in Princeton, N. J. A hall lamp containing it broke or exploded soon after it was lighted, and although the wick and chimney remained in their place, the oil which fell on the floor set fire to the carpet. No. 5 came from Paterson, N. J., where it had caused an explosion, scattering the burning oil about a room in which two children were sleeping. The proprietor, attracted by the noise, ran into the room and put out the flames with a bed-quilt. In answer to particular questions, I was told that the lamp was of glass, standing on a table, and that the noise heard was that of the explosion, and not of the falling or breaking glass.

From the above experiments the following conclusions may be drawn, as applying at least to these oils:

1, The naphthas distilled were comparatively heavy, 59° to 64° B., technically known as benzines.

2. The removal of about ten per cent. of these naphthas from an average unsafe oil, raised the flashing point 2.27°, and the burning point 1.6° F., for each per cent. removed; the addition of the same propor-

tion of naphtha of equal specific gravity, lowered the flashing point in very nearly the same ratio.

3. Table II. shows that a paying amount of a light naphtha, above 70° B., could not be added to even a very high grade oil without making it conspicuously bad, while as much as ten per cent. of a heavier naphtha (benzine), of 65° B., could be added to an oil of little above 100° F. flashing test, and make it no worse than much of the oil now in the market.

4. When a small amount of naphtha of above 70° B. is added to a good oil, the flashing point is lowered much more rapidly than the burning point: if the oil is of very high grade and the naphtha moderately heavy, 65° B., the burning point of the oil is lowered almost as rapidly as the flashing point; while the addition of a naphtha of 65° B. to a moderately good oil, flashing at 104° F., lowers the flashing point 85 to 40 per cent. more rapidly than the burning point.

5. The burning point is not a reliable test of the safety of an oil, since oils when spilled will ignite instantly on the approach of a flame, when heated a degree or two above their flashing point, even although the burning point is 10° or 20° F. higher. This fact has been so often shown to be true, and especially in the earlier volumes of the *American Chemist*, that it seems scarcely necessary to repeat it here.

6. Experiments I. and II. show that an oil flashing at 86° and burning at 107° F., can be made to flash at 100° F. by removing six or seven per cent. by distillation. This corresponds nearly with the estimate furnished to me by Mr. H. N. Rogers (Charles Pratt & Co., refiners), that average petroleum yielding 75 per cent. of 110° F. "fire test" (burning test) oil, would probably yield 69 per cent. of 100° "flash oil;" in other words, 8 per cent. of the 110° "fire test" oil, would have to be removed to make a 100° "flash" oil. The average flashing point of eight oils given in Dr. Chandler's report as burning at 110° F., was 89°.

XL—Preliminary Note on Litmus.

By Howard W. Mitchell.

(Read June 1, 1876.)

Wartha* has separated four organic bodies from Litmus. The first is obtained by treating commercial litmus with alcohol of about 90 per cent., filtering cold and boiling the clear tincture; whereupon indigo is precipitated as a fine powder, according to the author. The second body is obtained by evaporating the violet-red mother liquor; it is a beautiful red, or, from many varieties, green, fluorescent substance, indifferent to acids. The litmus residue left after the above treatment with alcohol, and which is insoluble in that fluid, is digested with distilled water for 24 hours, after which the deep-colored solution is evaporated to dryness on the water-bath, the residuary extract treated several times with absolute alcohol containing a little glacial acetic acid and again evaporated, until it forms a brown powdery mass. This brown powder is now extracted with absolute alcohol and acetic acid, whereby a large quantity of a scarlet-red body is dissolved, which resembles orceine and becomes purple-red, in place of blue, with ammonia. The portion of the brown powder insoluble in the acidified absolute alcohol consists of the litmus coloring matter in a state of great purity—so pure, in fact, that by means of it the carbonated alkaline earths contained in spring waters may be titrated with as great delicacy as by the use of cochineal tincture, which is far from being the case with crude litmus.

To get this perfectly pure, it is first washed with absolute alcohol, then dissolved in a small quantity of water and thrown into a large excess of alcohol; the

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*Ueber den Lakmusfarbstoff. V. Wartha, Ber. Chem. Ges. zu Berlin, 9, 217.

flocculent purple precipitate collected and again thoroughly washed with alcohol.

I have repeated Wartha's experiments as here stated upon some samples of litmus obtained from Bullock & Crenshaw, of Philadelphia, and said to have come from Pettitt, Aimee & Co., Paris, France. My observations confirm his results in every particular, save as regards the Indigo. No deposit of indigo was obtained upon boiling the alcoholic tincture, not even after repeated ebullitions, with intervals of rest and cooling.

The fluorescent body which he mentions, is violet or purple, as I have obtained it, and gives a solution in alcohol of a similar color, which shows a beautiful green fluorescence with sunlight, even when very dilute, and with the spectroscope gives a very characteristic absorption band in the green, together with an almost total absorption of the violet end of the spectrum.

It is soluble in water, amylic alcohol, and common ether to some extent, extremely soluble in alcohol, but seems to be wholly insoluble in bisulphide of carbon, chloroform, petroleum-naphtha, and oil of turpentine, imparting neither color nor fluorescent property to those liquids.

The solutions in amylic alcohol and in ether, both exhibit a beautiful fluorescence, but the ethereal solution shows the absorption band in the green only very faintly, even when the solution is thoroughly saturated. The solubility of the substance in both of these liquids is probably due to the trace of common alcohol, which they both contain, as found commercially. The body which resembles orcein shows a very faint fluorescence, and in alcoholic solution gives a spectrum in which the absorption is characteristic, and quite distinct from that of the last. It is slightly soluble in water, very soluble in alcohol, but seems to be insoluble in ether, chloroform, bisulphide of carbon and petroleum-naphtha.

The pure coloring matter proper of litmus is insoluble in alcohol, ether, chloroform, bisulphide of carbon, and petroleum naphtha, both in the cold and upon boiling; it is very soluble in water, and its aqueous solution yields an absorption spectrum differing from that of each of the preceding substances.

This substance turns blue with ammonia, and seems more like the azolitmine of Kane than either of the other substances, but I obtained no ammonia from it by heating with sodic or calcic hydrates, that is, sufficient to show its presence by odor or by reaction upon reddened litmus paper.

It yields in alkaline solution a beautiful violet lake with alumina, one of a pale violet color with stannous acetate, and deep blue lakes with calcium and barium.

The residue left, after extracting litmus with alcohol, and then with water, is soluble to the extent of 85 per cent. in dilute hydrochloric acid, and the portion dissolved in this liquid consists of calcic and magnesic carbonates, free from coloring matter, in the proportions of about 90 per cent. and 10 per cent. of the carbonates respectively. The residue, insoluble in dilute hydrochloric acid, consists mostly of fine sand, but yields some coloring matter to strong ammonic hydrate, and forms a solution of a blue color, with a precipitate, red and gelatinous, somewhat like alumina, upon super-saturation with an acid.

About 25 grains of the pure coloring matter, 15 grains of the body like orceine, and 10 grains of the fluorescent body, were obtained per ounce of litmus.

Diagrams of the absorption spectra yielded by these several substances I reserve for a second paper.

THE

AMERICAN CHEMICAL SOCIETY.

XIV.—Proceedings.

Regular Meeting, July 6th, 1876.

W. M. Habirshaw, Esq., in the Chair; 23 members present.

The minutes of the last meeting were read and adopted. The Secretary gave a brief account of the reunion of the Society at Philadelphia, June 16th, on the occasion of the dinner in honor of the foreign chemists officially connected with the Exhibition, which was attended by about seventy members of the profession.

The following members and associates were then elected:

Members.—Florian Alexander, Newark, N. J.; J. G. Allyn, Chicago, Ills.; E. H. L. Bailey, Bethlehem, Pa.; G. W. Belcher, St. Louis, Mo.; H. B. Cornwall, Princeton, N. J.; C. Lewis Diehl, Louisville, Ky.; F. P. Dunnington, Lexington, Va.; Persifor Frazer, Philadelphia, Pa.; Samuel W. Johnson, New Haven, Ct.; George A. Koenig, Philadelphia, Pa.; Samuel Morris Lillie, New York; C. I. Lawler, Brooklyn, N. Y.; Howard W. Mitchell, Philadelphia, Pa.; John A. Myers, Irvington, Ind.; T. J. Parker, New York; Richard Pearce, Black Hawk, Col.; Frederick Prime, Jr., Easton, Pa.; C. M. Roeper, Bethlehem, Pa.; Henry Morton Seely, Middlebury, Vt.; William S. Sweeny, Easton, Pa.; E. L. Youmans, New York; W. J. Youmans, New York; Herman Voorhies, New Brighton, S. I.; Theodore R. Wolf, Wilmington, Del.

Associates.—Edward N. Dickinson, George Elder, Jr., Adolph Hallgarten, H. O. Havemeyer, Theodore Havemeyer, John Habirshaw, F. Jones, Chas. V. Mapes, F. O. Mathiesen, Wm. A. Miles, W. J. Parsons, S. M. Plympton, New York; John H. Ricketson, Pittsburgh, Pa.; Chas. H. Senff, Austin G. Day, Julius H. Striednger, Joseph Gandolfo, New York.

The names of 14 candidates for Election were presented to the Society.

The paper announced by A. Borngouguon was withdrawn on account of the illness of the author. Rufus S. Merrill, of Boston, Mass., read a paper on "Explosions and the Proper Method of Testing Petroleum Oils," with illustrative experiments. On motion, the thanks of the Society were tendered to Mr. Merrill. A paper by Prof. Paul Schweitzer, "On Some New Acid Ammonium Sulphates," was read by the secretary. Charles M. Stillwell read a paper "On the Occurrence of Vanadium in American Hematites and Limonites."

The Society adjourned, to meet again on the first Thursday in September or October, according to the decision of the Council.

I. WALZ, *Recording Sec'y.*

XV.—ON THE OCCURRENCE OF VANADIUM IN AMERICAN HEMATITES AND OTHER SECONDARY IRON ORES.

BY CHAS. M. STILLWELL, A.M.

(Read July 6, 1876.)

AT the last meeting of the American Chemical Society it will be remembered that Dr. Walz read a paper on the Occurrence of Vanadium in American Magnetites. He pointed out the probability of its occurrence in the secondary ores of iron, namely the hematites and limonites. As he was unable to undertake their examination the task fell to me, and I have the honor to-night to present my results to the Society.

Before treating of the proper subjects of this paper I wish to give the results of my examination of two magnetic iron ores. The opinion was expressed by Dr. Walz that vanadium is almost always found in larger quantities in titaniferous magnetites than in magnetites free from titanium. A sample of the Cumberland iron ore, a magnetic titaniferous ore from Cumberland, R. I., was analyzed, and vanadic acid was found to the amount of 0.18 per cent. As this analysis seemed to confirm the above view, I determined to test the question still further by analyzing separately the magnetic and titaniferous portions of one of the iron sands. For this purpose I selected the titaniferous iron sand from Long Island; equal weights of the magnetic and the titaniferous portions of the ore were analyzed, with the following results:

Per cent. of vanadic acid, V_2O_5, in magnetic portion, 0.04. Per cent. of vanadic acid, V_2O_5, in titaniferous portion, 0.08.

If we remember that the titaniferous portion of the ore includes the large amount of sand and other impurities which are constituents of this ore, we see that, as expected, the vanadic acid is in iron ores principally associated with the titaniferous portions. The per centage of vanadic acid in this sample as a whole is as follows:

			V_2O_5
Magnetic portion,	19.60	containing	0.007
Non-magnetic portion,	80.40	"	0.064
	100.00	Total	0.071

The method used in the examination of the secondary iron ores was by fusion with five times their weight of a mixture of equal parts of sodic carbonate and flowers of sulphur, extraction with water, precipitation of the vanadic sulphide, mixed with sulphur, by chlorohydric acid, and removal of the sulphur by carbon disulphide. It was noticed that from these

ores a larger amount of impurities is taken up by the fusion and carried into the final precipitate of vanadic sulphide than is the case with the magnetites. No quantitative determinations of the amount of vanadic acid were made in the secondary iron ores.

With the exception of five ores, vanadium is present in only minute traces in the samples examined. It was found, too late, that one gramme of ore is not sufficient to give amounts of vanadic acid large enough for complete determinative tests. Four or five grammes of ore should be taken for analysis in the case of these ores. The examination being made with one gramme of ore in all cases, and the flux and treatment being the same for each sample, the resulting precipitates of vanadic sulphide can be very closely classed together by an inspection of the filters containing such precipitates.

In order to identify the precipitate of vanadic sulphide where it is present in very small amount, it is well to employ, in addition, a blowpipe test. Vanadic acid with borax in the oxydizing flame is dissolved to a limpid glass, which, when the quantity of vanadic acid is small, is colorless; when larger, yellow; and on cooling becomes greenish. In the reducing flame the glass while hot appears brownish, and assumes a fine green color on cooling. A very characteristic reaction is that given in the reducing flame, when a certain quantity of vanadic acid will give a colorless bead, and immediately on removal from the flame a spot of brownish-red color forms with streaks shooting throughout the bead.

I am indebted for the samples of secondary iron ores, other than those from Alabama, to the kindness of Professor Newberry, and for those from Alabama to Professor Eugene A. Smith of that State.

In the following list the amount of vanadic acid is not over 0.10 per cent., judging from the amount of the precipitates of vanadic sulphide found:

Hematite in fissure of Trenton limestone, Marmora, Canada West.

Staten Island ore, Staten Island, N. Y.

Iron Mountain ore, Missouri.

Hematite, St. Clair Co., Alabama.

Fossiliferous ore, Lewistown, Pensylvania.

In the following list the amount of vanadic acid is very small, and in most of the ores it is present in mere traces:

Hematite, Jefferson Co., Ala.

Fossiliferous ore, Rockwood, Roan Co., Tenn.

Limonite, cone ore, Shaftsbury, Vt.

Clinton iron ore, Clinton, N. Y.

Specular iron ore, Marquette, Mich.

Specular iron ore, near Paranan, Utah.

Limonite, Talludega Co., Ala.

Limonite, Etowah Co., Ala.

Limonite, Bibb Co., Ala.

Limonite, Staten Island, N. Y.

Rossie ore, Rossie, N. Y.

Bog iron ore, Sylvania, Ohio.

Spathic iron ore, Roxbury, Conn.

Specular iron ore, Bill William's Fork, Colorado River.

Black Band ore, Pottsville, Pa.

Vanadium occurs, therefore, in the largest amounts in the primary iron ores, as shown by Dr. Walz in his paper read before the American Chemical Society, June 1, 1876. It is present in small amounts in the secondary iron ores, as shown by my examination of the above-named ores; and the observation of Dr. A. A. Hayes, in his paper presented to the American Academy of Sciences, Jan. 12, 1875, that vanadium is widely diffused in the waters of drainage, is in perfect accordance with these results.

XVI.—Some New Acid Ammonium Sulphates.

BY PAUL SCHWEITZER, PH.D.

(Read July 6, 1876.)

In the course of an investigation into the methods of determining sulphuric acid, I subjected ammonium sulphate to various degrees of heat and noted the loss which it sustained by decomposition; certain regularities were thereby observed, which led me to determine the quanity of sulphuric acid in the products obtained, from which I deduce the existence of at least one new compound of ammonium and sulphuric acid.

Neutral ammonium sulphate, exposed to a moderate degree of heat, loses at first quietly and without effervescence, one-half of its ammonia; and then, with rising temperature and under lively effervescence, an additional fourth of ammonia and of sulphuric acid. In the former case the requisite temperature is a little higher than the boiling point of mercury, and the mass of a pasty and viscous condition; in the latter case below incipient red heat, and the mass a thin mobile liquid in a lively state of effervescence; both conditions are easily observed and products obtained of a uniform composition; in fact, in the latter case, the mass may be cooled at any time before complete volatilization, and furnish the salt in question. Both salts present, after cooling, crystalline masses of greater toughness but inferior hardness than melted potassium bisulphate, to which they bear a general resemblance; they absorb water but slowly, and ammonia from a dry atmosphere with extreme reluctance.

1. $(NH_4)_2.SO_4$. *Ammonium Sulphate.*—The salt employed was pulverized and dried at 100° C., and contained in 1.5081 gr.=2.6728 gr. $BaSO_4$=0.9177 gr. SO_3=60.8514 per cent., and may be supposed to have been pure, as theory would require 60.6061 per cent. of SO_3.

2. $NH_4H.SO_4$. *Ammonium Bisulphate.*—The previous salt was heated until the thick pasty mass ceased to give off ammonia, when it was analyzed, yielding in 1.7980 gr.=3.6180 gr. $BaSO_4$=1.2408 gr. SO_3= 69.1746 per cent. It was then heated for fifteen minutes longer, when it gave on analysis in 1.9267 gr.=3.9004 gr. $BaSO_4$=1.3390 gr. SO_3=69.4971 per cent. No change had taken place in the composition of the substance by the second heating, which is proof, I think, of the existence of a stable compound. The acid sulphate requires by theory 69.5652 per cent. of SO_3.

3. $(NH_4)_2 H_4 (SO_4)_2$., *Biammonium Tetrahydrogen Sulphates.*—The remainder of the previous salt was heated higher, until effervescence set in and 3 gr. had been volatilized off; it gave on analysis in 1.2159 gr.=2.5681 gr. $BaSO_4$=0.8818 gr. SO_3=72.5224 per cent. The rest was heated a second time, until another 3 gr. had been volatilized, when the remainder was analyzed, giving in 0.8637 gr.=1.8353 gr. $BaSO_4$= 0.6301 gr. SO_3=72.9536 per cent.

There is no difference in the two results, which agree closely with the percentage of sulphuric acid in a more acid ammonium sulphate, which, if of the above formula, requires 73.1717 per cent. of SO_3. There was no trace of sulphurous acid found in the salt.

The reactions, according to which the two salts are probably obtained, are these:

1. $(NH_4)_2SO_4 = NH_4H.SO_4 + NH_3$.

2. $4(NH4HSO_4) = (NH_4)_2H_4(SO_4)_3 + SO_2 + 2H_2O + N_2 + H_4$.

Of other analyses made of products obtained by the application of a lower degree of heat, I mention two more, which correspond to a salt of the formula $(NH_4)_4H_2(SO_4)_3$, which requires 66.2983 per cent. of SO_3, without, however, having verified the existence of this salt by additional experiments. It occupies about the relative position to the preceding salt that

neutral ammonium sulphate occupies to the ordinary bisulphate; these are the figures: 2.1739 gr.=4.1934 gr. $BaSO_4$=1.4396 gr. SO_3=66.221 per cent. 1.4495 gr.=2.8077 gr. $BaSO_4$=0.9639 gr. SO_3=66.499 per cent.

Ammonium bisulphate, placed under a bell-jar with a vessel containing water, increased in weight by absorption in the following ratio:

1.3896 gr. NH_4HSO_4.			
1.0439 "	= 3.159 per cent.	after	24 hours.
0.1089 "	= 7.887 "	"	two days.
0.1387 "	= 9.981 "	"	three "

Another sample, placed in an atmosphere of ammonia, generated from a mixture of sal ammoniac and slacked lime, increased in weight in the following manner:

2.1251 gr. $NH_4H.SO_4$.			
0.0024 "	= 0.113 per cent.	after	24 hours.
0.0030 "	= 0.141 per cent.	after	two days.
0.0038 "	= 0.179 "	"	three "

STATE UNIVERSITY OF MISSOURI.

XVII.—PROCEEDINGS.

Regular Meeting, September 7, 1876.

Prof. CHANDLER in the chair. 25 members present.

THE following were elected:—*Members:* C. Elton Buck, Wilmington, Del.; Alonzo Chase, Albany, N.Y.; Geo. W. Hawes, New Haven, Conn.; John W. Langley, Ann Arbor, Mich.; Dr. C. A. Martius, Berlin, Germany; Wm. Schrage, Sheboygan, Wis.; Wm. T. Wenzell, San Francisco, Cal.; Chas. King and E. G. Love, New York. *Associates:* Douglass Campbell, Chas. W. Havemeyer, Wm. O. Stoddard, New York; W. D.

Russell, Newark, N. J.; George Shepard Page, Stanley, N. J. The following were proposed :—*Members :* Chas. A. Pitkin, Newport, R. I.; Prof. Mariano Barcena, Mexico; Wm. Hodgson Ellis, Toronto, Canada; Bruno Terne, Chicago, Ill.; Otto Wuth, Pittsburgh, Pa.; S. A. Goldschmidt, New York. *Associat s:* W. R. Elmenhorst, Jersey City, N. J.; P. Munziger, Philadelphia, Pa.; Frederick W. Senff and Jas. C. Baylis, New York.

The following papers were read:

A. Bourgougnon :—Pennsylvania Petroleum.

F. P. Dennington (University of Virginia) :—Method of Determining Sulphur in Coal.

P. Casamajor:—Estimation of Potassium as Potassium Tartrate.

Adjourned.

I. WALZ, *Recording Secretary.*

XVIII.—PENNSYLVANIA PETROLEUM.

BY A. BOURGOUGNON.

(Read Sept. 7, 1876.)

THE subject of this communication is the composition of Pennsylvania crude petroleum as sold in the New York market. The composition of this oil differs from that of the oil which is taken directly from the wells, since it is known that the tanks are filled with oil yielded by several wells, and the product of two wells, even in the same neighborhood, sometimes differs greatly.

In the next communication I will be able to bring before the Society the result of the analyses of several samples of crude oil taken directly from the wells.

According to Rule Four of the New York Produce Exchange, crude petroleum is understood to be pure natural oil, neither steamed nor treated, and free from

water, sediment, or any adulteration, and of a gravity of 44° to 48° Baumé. An allowance shall be made to the buyer, of one half of one per cent. for every quarter of a degree above 48° gravity.

The specific gravity of the New York crude oil ranges generally from 0.790 to 0.800, corresponding to 48° to 46° of Baumé's areometer, at the temperature of 15° C.

The odor of the pure crude oil is *sui generis*, and not of a very offensive character; it is true that sometimes complaints have been made against the smells produced in the refineries, but these very offensive odors are produced only when the crude oil or residues are superheated, with the view of "cracking" the oil, in order to produce a larger percentage of kerosene.

The color is very variable; some oils being dark, others only light colored. The color is generally green, affecting a brownish tinge through transmitted light. The oil known in the market under the name of Parker's Landing oil is of a pale brownish color.

The coefficient of expansion of the crude oil varies from 0.00082 to 0.00086, according to the amount of naphtha contained in the oil. These coefficients are in relation to the gravity of the crude oil, and for the products of distillation the following numbers can be generally adopted with satisfactory results:

Under 0.700	gravity at	15° C.,	0.00090
Above 0.700 to 0.750	"	"	0.00085
" 0.750 " 0.800	"	"	0.00080
" 0.800	"	"	0.00070

The knowledge of these coefficients is important, as it aids in calculating the empty space which must be allowed in the vessels containing the oil. This space will be:

V.K.50.

V representing the volume of the oil, K the coefficient of expansion, and supposing that the oil is to be submitted to a change of temperature of 50°.

In each transaction of petroleum, the oil is to be analyzed, and inspectors are licensed for this purpose by the New York Produce Exchange.

Generally the inspectors examine the density and the odor, and how the oil feels with the fingers, and make a fractional distillation in tenth parts, giving a report stating that the oil does not contain more than seventeen per cent. of naphtha.

When first I inspected crude oil, I made also fractional distillations in tenths; but very soon I rejected this system, because I could not in this way determine the exact proportion of naphtha contained in the oil, and this determination is very important to the buyer, since the crude oil is taxed in foreign countries according to the quantity of naphtha contained in it.

To give more accuracy to my results, I made the distillations in one hundredth parts, and I will add that this is the only way to obtain a correct analysis of crude oil, and also the real percentage of naphtha, benzine, burning oil, etc.

The following analysis, made by fractional distillation in one hundredth parts, will show the average composition of the crude petroleum of the New York market:

Per cent	Gravity.	Baumé.	Per cent	Gravity.	Baumé.	Per cent	Gravity.	Baumé.	Per cent	Gravity.	Baumé.	Per cent	Gravity.	Baumé.
1	0.679	78	21	0.730	63.2	41	0.766	53.9	61	0.792	47.8	81	0.830	39.4
2	0.680	77.7	22	0.732	62.7	42	0.768	53.5	62	0.794	47.3	82	0.830	39.4
3	0.685	76.2	23	0.734	62.1	43	0.769	53.2	63	0.796	46.9	83	0.829	39.7
4	0.690	74.6	24	0.735	61.7	44	0.770	53	64	0.798	46.4	84	0.827	40.1
5	0.693	73.7	25	0.736	61.6	45	0.771	52.7	65	0.800	46	85	0.826	40.3
6	0.695	73.1	26	0.737	61.3	46	0.772	52.5	66	0.804	45.1	86	0.825	40.5
7	0.698	72.3	27	0.742	60	47	0.773	52.2	67	0.806	44.6	87	0.823	40.9
8	0.700	71.7	28	0.746	59	48	0.775	51.8	68	0.808	44.2	88	0.825	40.5
9	0.703	70.8	29	0.749	58.2	49	0.776	51.5	69	0.810	43.7	89	0.824	40.7
10	0.705	70.2	30	0.750	58	50	0.777	51.3	70	0.815	42.6	90	0.825	40.5
11	0.707	69.6	31	0.751	57.7	51	0.778	51	71	0.817	42.2	91		
12	0.709	69.1	32	0.753	57.2	52	0.780	50.6	72	0.819	41.8	92		
13	0.711	68.5	33	0.754	56.9	53	0.781	50.3	73	0.821	41.3	93		
14	0.712	68.2	34	0.755	56.7	54	0.782	50.1	74	0.823	40.9	94		
15	0.714	67.7	35	0.756	56.4	55	0.783	49.9	75	0.825	40.5	95		
16	0.717	66.8	36	0.758	55.9	56	0.784	49.6	76	0.826	40.3	96		
17	0.719	66.2	37	0.760	55.4	57	0.785	49.4	77	0.827	40.1	97		
18	0.721	65.7	38	0.761	55.2	58	0.786	49.2	78	0.828	39.9	98		
19	0.723	65.1	39	0.763	54.7	59	0.788	48.7	79	0.829	39.7	99		
20	0.728	63.8	40	0.765	54.2	60	0.790	48.2	80	0.829	39.7	100		

Residuum or Loss.

COMPOSITION.

The composition of the crude oil furnished by the above distillation is as follows:

Naphtha,	0.700	specific gravity,	17 per cent.
Benzine,	0.730	"	9 "
Burning oil,	0.788	"	64 "
Residuum—Loss, . . .			10 "

The specific gravity of the crude oil was 0.7982, or 46.5° Baumé.

All the above specific gravities are corrected for the temperature of 15° C.

Very often the crude oil does not contain so much naphtha, but generally the New York oil will furnish:

12 to 15 per cent.	naphtha,	at 0.700	sp. gr.
9 " 12 "	benzine,	" 0.730	"
and about 60 "	burning oil,	" 0.795	"

The residuum contains about 2½ per cent. of dry paraffine, calculated for the quantity of crude oil submitted to distillation.

During the distillation, the products are more and more heavy until the heat produced decomposes the oil in the still, then the oil is dissociated, and by this dissociation, or "cracking," lighter and also more inflammable products are obtained. At the same time this decomposition is accompanied by a formation of carbon, which is deposited in the still, and gases of a very offensive odor pass off with the oil. Some refineries are provided with apparatus to collect and burn these gases.

The average daily consumption, as near as can be estimated, is 6,000 barrels per day of refined oil in the United States; of this Cleveland refines ⅔, New York ⅙, Pittsburgh and other small places ⅙.

Cleveland supplies all the West, and also a large part of the Eastern States; Pittsburgh supplies the South and South-west, and New York the Middle and South Atlantic States.

The regular dealing in petroleum dates from 1859, and the yearly production since that date, in the Pennsylvania oil regions, is as follows:

Year.	Barrels, 42 Gallons.	Year.	Barrels, 42 Gallons.
1859	82,000	1868	3,715,700
1860	500,000	1869	4,215,100
1861	2,113,600	1870	5,659,000
1862	3,056,700	1871	5,800,000
1863	2,611,800	1872	6,300,000
1864	2,116,100	1873	9,883,000
1865	2,497,700	1874	10,925,973
1866	3,597,700	1875	8,788,506
1867	3,347,300		

EXPORT FROM NEW YORK IN 1875.

Refined oil	1,975,967	barrels.
Crude "	195,806	"
Naphtha	194,345	"
Residues	31,090	"
Lubricating oil	2,145	"
Total	2,399,353	"
Refined oil	2,314,351	cases.
Naphtha	5,900	"
Gasoline	1,000	"
Total	2,321,251	"

The largest part of the crude oil and naphtha is sent to France, and most of the refined oil is sent to Bremen and Antwerp; these two places being the largest European oil markets.

The small quantity of residues shipped in 1875 was for England. These residues are used for the manufacture of illuminating gas. The refined oil shipped in cases is chiefly for Turkey, Spain, India, China, and Japan. A case contains 10 gallons.

XIX.—Method of Determining Sulphur in Coal.

BY F. P. DUNNINGTON.

(Read Sept. 7, 1876.)

Having noticed in a recent number of the *Chemical News* the composition of a flux (nitre 202 parts, and carb. soda 53 parts, fused) which will not oxidize platinum at a red heat, I found considerable difficulty in avoiding loss of material in its use when much effervescence took place. Desiring to prevent the latter, I found two parts of lime sufficient to keep the mass porous. This gave a ready means of oxidizing by fusion; but lime sulphate not being very soluble, at the suggestion of Dr. J. W. Mallet, I substituted magnesia carbonate, one part proving sufficient.

The flux readily obtained free of sulphur is kept dry in the fused cake, and powdered immediately previous to use. The magnesia must be prepared free of sulphate.

The following results were obtained, using a bituminous coal, which gave by fusion with potash .835 per cent. sulphur, and a pyrites which gave by nitric acid 51.05 per cent. sulphur:

			Found.	Calculated.
1°, Coal	.1563	gram.		
Pyrites	.02945	"	—	—
Flux	3.	"	Sulphur .01602	.01684
Magnesia	3.	"	per ct. 8.6	8.8

			Found.	Calculated.
2°, Coal	.29325	gram.		
Pyrites	.0390	"	—	—
Flux	5.	"	Sulphur .02245	.02225
Magnesia	5.	"	per ct. 6.76	6.73

The balance employed indicating to $\frac{1}{10}$ m.grm. These determinations of sulphur in coal are quite accurate with these small amounts of material, while made so readily. The following method is employed:

The pulverized coal is mixed with fifteen parts of flux, in an agate mortar or glazed dish, and then fifteen parts of magnesia are added. The mixture is transferred to a platinum crucible, covered, and after warm-

ing, a small flame of a Bunsen burner will complete the fusion in two or three minutes. The sulphates are readily removed from the cool mass by three or four washings with boiling water, filtered, acidified with hydrochloric acid, warmed, and precipitated as dusal with barium chloride, being careful to purify the precipitate with copper acetate.

This addition of one part magnesia or two parts lime may also be advantageously employed in fusing with this flux iron ores mixed with silicates, for volumetric determinations. An iron ore (carbonate and silicate), which required two hours or more to be decomposed by hydrochloric acid, was mixed: Ore, 1 part; flux, 2 parts; magnesia, 3 parts; heated for five minutes over a Bunsen burner, after which all the iron was immediately soluble in acid.

XX.—Estimation of Potassium as Acid Tartrate.

BY P. CASAMAJOR.

(Read Sept. 7, 1876.)

In most cases which present themselves to the chemist, in which potassium is to be estimated, it is accompanied by sodium, and the course usually pursued is to estimate the potassium directly as platino-potassic chloride. The precipitate obtained has the advantage that its weight is very great when compared to the weight of potassium in combination. There are difficulties, however, connected with the process, and there are cases in which it is not applicable without elaborate preparation; but platinic chloride, although expensive, is an excellent reagent, and, in experienced hands, very good results are obtained by its use.

Indirect processes are also in use, one of which consists in combining potassium and sodium with either chlorine or sulphuric acid, and in estimating the total quantity of salts by one operation, and the quantity of either chlorine or sulphuric acid by another operation. From these two quantities the potassium and sodium can be calculated. Very good retsuls are also obtained by this process.

There is also a very curious indirect process due to Gay Lussac, to which I call your attention, because I believe that it is not generally known, and because it presents a singular example of the expedients to which chemists have resorted to estimate potassium in presence of sodium. This process, which was in use some years ago in French saltpetre works, and may still be in use, is based on the following facts: When 50 grammes of pure chloride of potassium are dissolved in 200 cubic centimetres of water, the temperature of the liquid falls 11.4° Centigrade. If we take 50 grammes of chloride of sodium, the fall of temperature will be only 1.9° C. Gay Lussac has directed that the glass vessel in which the solution takes place should weigh 185 grammes, a point of some importance, as the vessel must acquire the temperature of the liquid it contains. To test a mixture of potassium and sodium salts, they are brought in the first place to the state of chlorides and dried, and 50 grammes of the mixture are taken and dissolved in 200 cubic centimetres of water. A decrease of temperature is noted, and the proportions of potassium and sodium chlorides are obtained from a table in which these proportions are placed opposite numbers indicating the decrease of temperature. If this table is not at hand, the quantity of potassium chloride, in 100 parts of the mixture, may be found by calling the percentage of chloride of potassium x, and the decrease of temperature in degrees C., d. Then $100 - x$ will be the percentage of sodium chloride, and we shall have:

$$100\,d = 11.4\,x + 1.9\,(100 - x)$$
$$100\,d = 11.4\,x + 190 - 1.9\,x$$
$$100\,d = 9.5\,x + 190$$

whence

$$x = \frac{100\,d - 190}{9.5}.$$

My purpose this evening is to describe a process for the estimation of potassium as acid tartrate, a process which has the advantage of being direct, and which

gives results much more rapidly than can be obtained by any other means, while for accuracy they compare favorably even with those obtained by platinic chloride.

The occasion which led me to estimate potassium as acid tartrate was a series of experiments on the process of Messrs. Duncan and Newlands for separating potassium from the low products of sugar-houses by the addition of sulphate of alumina, and the consequent production of potassium alum. To avoid an excess of sulphate of alumina, which would be a waste, it became necessary to ascertain the quantity of potassium in each batch of products. For this determination platinic chloride is not very well adapted, as the first requisite was celerity rather than accuracy. The use of platinic chloride requires, in the first place, a thorough destruction of the organic matter by heat. The ashes, obtained as sulphates, are treated, in the next place, by an excess of barytic chloride, which gives a solution containing the chlorides corresponding to the sulphates in the ashes, and an excess of barytic chloride. From this solution, properly reduced in volume, potassium may be precipitated by platinic chloride.

Instead of this series of preparatory operations, to be followed by those required by the nature of the double chloride, it occurred to me, at first, to treat a small quantity of the low saccharine product by an excess of sulphate of alumina, and, from the quantity of alum obtained, to calculate that of sulphate of alumina required for the quantity of low products to be treated on a large scale. This idea afterwards led to that of substituting tartaric acid for sulphate of alumina, and, on trying tartaric acid, the results were so uniform and satisfactory that I was induced to apply it to the determination of potassium in compounds of all kinds.

Cream of tartar presents, over every other com-

pound of potassium, the incomparable advantage that, while its solubility is very feeble, the estimation of it by a titrated alkaline solution is an operation that only takes a few minutes. To determine the quantity of cream of tartar that we may have to analyze, it can be placed in a beaker glass with a sufficiency of water, which it is advantageous to heat, to increase the solubility of the acid tartrate. A few drops of litmus solution will impart a red color, which will persist as long as any cream of tartar remains in the solution. If now we add a solution of potassa, drop by drop, to the contents of the beaker glass, the acid tartrate will be converted to the basic, and, while the change is going on, the unconverted cream of tartar will continue to color the litmus red. When the last particle of acid tartrate has been converted to the basic, an addition of the smallest particle of potassa solution will turn the litmus blue. We may now note that the quantity of potassa added to convert the acid tartrate into the basic is exactly the same as the quantity already in combination as acid tartrate. We may note, moreover, that the equivalent of cream of tartar is exactly four times greater than the equivalent of potassa, so that if we have added one gramme of potassa to turn the litmus blue, we must have had four grammes of acid tartrate, holding in combination one gramme of potassa. After every addition of potassa, the contents of the beaker should be thoroughly stirred, to dissolve the portions of acid tartrate which are undissolved, but which gradually become soluble as potassa is added. Before the change to the basic condition is complete, the crystals of bitartrate disappear, and the red solution becomes perfectly clear. This is an indication that the end is near.

That acid tartrate of potassium is so well adapted to being tested by the titrated alkaline solution is the quality which, combined with its feeble solubility,

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recommended it as the compound in which to obtain potassium for analysis. We must, however, increase its insolubility if accurate results are to be obtained, and this can be easily accomplished by means of alcohol.

The insolubility of cream of tartar in a mixture of alcohol and water is greater than in pure water. The following table, given by Chancel, shows the solubility of cream of tartar in water at several temperatures.

Degrees C.	100 c.c. of water dissolve grammes of cream of tartar.
0	0.24
5	0.30
10	0.37
15	0.45
20	0.55
25	0.67
30	0.805
35	0.96
40	1.13

Having had occasion to use this table repeatedly, I have verified these numbers and found them correct.

Chancel has also given us another column, representing the number of grammes of cream of tartar which 100 c.c. of water, containing 10 per cent. alcohol, will dissolve at the same temperatures. These numbers are nearly 57 per cent. of those corresponding to pure water.

To discover the minimum of alcohol which will render a mixture with water incapable of dissolving cream of tartar, a great many experiments were made, and it was found that the mixture containing 60 per cent. of alcohol fulfils this condition. By bringing all the liquids containing acid tartrate of potassium to the condition of containing at least 60 per cent. of alcohol in volume, I have been able to obtain the whole potassium in the shape of insoluble cream of tartar.

Alcohol of this strength is not, however, to be used from the first, as it may in some cases interfere with the solution of the compounds to be analyzed, and sometimes our potassium may be precipitated in other forms than cream of tartar. It should only be used at the last stage, immediately before throwing the precipitate on a filter, so that the acid tartrate in solution may be thrown down. It should also be used to wash the precipitate on the filter, to free it from tartaric and acetic acid, as we shall see hereafter.

To enable me to explain the method of procedure in estimating potassium as acid tartrate, let me take the simplest case which can present itself, which is the analysis of a solution of pure potassa in water. Suppose we have a deci-normal solution of potassa, containing 47 milligrammes of potassa for every cubic centimetre of solution. If we drop 10 c.c. in a beaker glass, we may convert the whole of it into acid tartrate if we add a sufficient quantity of tartaric acid. As to what constitutes a sufficiency, we may note that there ought to be enough to precipitate all the potassium to be tested, the minimum being four times as much acid as there is potassium in the compound. We may, however, use a quantity of tartaric acid six times greater than the quantity of potassium to be precipitated. Beyond this, in the presence of alcohol, the precipitate is apt to contain an excess of acid. I am unable to say in what shape this excess of acid exists, but if we use a marked excess of tartaric acid, as much as ten or twelve times more than the potassium to be precipitated, the test by a titrated solution of potassium will give an excess of 2 or 3 per cent. If we have any means of getting approximately at the quantity of potassium in a substance to be tested, we should use six times as much tartaric acid as the supposed quantity of potassium. If, on making the test, we should find that we have gone too wide of the mark, the quantity obtained in a first test will allow

us to determine, to a certainty, the quantity to be used in a subsequent analysis. As every test takes less than one hour, both tests together will take up less time than a single analysis by any other process.

If we should be in entire ignorance of the quantity of potassium in a compound to analyze, we should take a large quantity of tartaric acid, not more, however, than three times as much as the quantity of material weighed for analysis, as the monosulphide, which is the compound having the greatest percentage of potassium, has 71 per cent., which, multiplied by 4, gives 2.84. The next in order, potassic hydrate, has nearly, but not quite, 70 per cent.

To return to the 10 c.c. of deci-normal solution, we may note that they contain 47 centigrammes of potassa, corresponding to 39 c.g. of potassium. We may then weigh approximately 2 grammes of tartaric acid, which is a little less than six times the quantity of potassium to be precipitated. This acid is dissolved and added to our 10 c.c. of deci-normal solution. The liquid should now be stirred sufficiently to make a thorough mixture of the solutions of potassa and tartaric acid. The crystals begin to deposit almost immediately, and the deposition increases for about five or six minutes, when it stops, and the liquid clears up. Alcohol should now be added to increase the precipitate. This addition, however, requires a few words of explanation.

As the result of numerous estimations of potassium in compounds of various kinds, I have found it advantageous to add, at first, only a small quantity of alcohol, a volume about $\frac{1}{10}$ of the liquid in the beaker glass. After this addition, the liquid should be stirred sufficiently to effect a thorough mixture, and then be allowed to rest five or six minutes, when the liquid above the precipitate becomes clear once more. Finally, the rest of the alcohol should be added, a quantity sufficient to make the whole liquid in the

beaker glass contain at least 60 per cent. of alcohol in volume. The liquid in the beaker should be stirred up once more, and after becoming clear it should be thrown on a filter.

To insure in an easy manner a quantity of alcohol equal to 60 per cent. of the total volume of liquid, I mark on the side of a beaker glass a line corresponding to 50 c.c., which is easily done with a file previously moistened with petroleum or spirits of turpentine, to prevent the abrasion from cracking the glass. Fifty cubic centimetres are quite sufficient when we take one gramme of material for analysis. The volume of the beaker glass should be at least 200 c.c. This volume of 50 c.c. is for the solution in water before adding alcohol.

In the case we have on hand we have dropped 10 c.c. of deci-normal solution of potassa in a glass, and added a solution of tartaric acid. We may now add water up to the mark indicating 50 c.c.

On the other hand, we have strong alcohol, say of 98½ per cent., which is the strongest common alcohol found in the market, and which is sold under the name of 95 per cent. alcohol. I have no intention of giving rules for mixtures of alcohol and water, which are familiar to most chemists. In this case, I will call your attention to this: that if you add 100 c.c. of 98½ per cent. alcohol to the 50 c.c. of liquid in the beaker glass, the result will be 150 c.c., and if we divide 98½ by 150, the result, .623, will be the strength of alcohol required.

After adding about 10 c.c. of strong alcohol to the 50 c.c. of solution in our beaker glass, we finally add the rest of the 100 c.c. After the deposition of crystals has stopped, the contents of the beaker are thrown on a filter. It is very important when there is sodium present not to wait too long before throwing the precipitate on the filter, as otherwise the results obtained are inaccurate. I propose to examine this

question in a future communication. The liquid that filters through gives a distinct red color to litmus paper. The precipitate on the filter should now be washed with alcohol of 80 per cent., until the filtered liquid ceases to show a red color with litmus paper. The precipitate after this is ready to be washed down into a beaker glass to be tested with potassa, after the liquid in the glass has been sufficiently heated and colored with litmus.

The glass containing cream of tartar in water is placed under a burette, and, if the operation has been carefully conducted, it will take exactly 10 c.c. of the deci-normal potassa solution to turn the liquid in the beaker glass from red to blue.

The condition of a solution containing only potassa and water is one that very rarely, if ever, presents itself in chemical analysis, and we have, in the next place, to ascertain the influence of bodies which are usually found in combination, or in a state of mixture with potassium.

If we drop 10 c.c. of a deci-normal solution of potassa in a glass, and add a few drops of solution of litmus, we will be able to find the quantity of sulphuric acid, added drop by drop, which will neutralize the 10 c.c. of potassa. After doing this, if we add, as before, 2 grammes of tartaric acid dissolved in water, a very slight precipitate will be obtained, even after standing for hours, and, however much the liquid may be stirred, or whatever quantity of alcohol we may add, the precipitate does not increase perceptibly. If instead of stopping at neutrality, a sufficient excess of sulphuric acid is added, tartaric acid will not show the least turbidity after continued agitation and addition of large quantities of alcohol. Hydro-chloric acid in the same circumstances behaves exactly in the same manner, as is also the case with nitric and phosphoric acids. From the behavior of potassic bromide and iodide, when in presence of an

excess of tartaric acid, we must conclude that hydrobromic and hydro-iodic acid belong to the same category.

With all these acids, a quantity sufficient for neutralization of the potassa gives a slight precipitate, while an excess prevents precipitation. In the first case, the precipitate produced can only take place by liberating a quantity of the acid in combination, and after a sufficient quantity of free acid has been formed, further deposition is prevented. The acids experimented on were powerful mineral acids, whose affinities for potassium are so great that, although the acid tartrate is more insoluble than any of their potassic compounds, they only yield a small portion of potassium to tartaric acid. If therefore a weaker acid than the tartaric was chosen to combine with potassium, it would not prevent the production of an abundant deposit of acid tartrate. Acetic acid naturally suggested itself, and, on being tried, was found incapable of preventing this precipitation. Here then was our way out of the difficulty.

Before describing the manner in which this property of acetic acid was utilized, we must, for the better understanding of the subject, state that salts of sodium in a solution containing 60 per cent. of alcohol do not prevent the precipitation of cream of tartar. The sulphate, the nitrate, the chloride, iodide, and bromide, the tartrate and acetate seem equally powerless to prevent the formation of the precipitate. This is an important point, as, by means of soda, or its carbonate, we may separate the bases that accompany potassium, and ammonia, whose acid tartrate is very insoluble, may, in presence of soda, be driven off by heat. The property that acetic acid possesses of allowing the completed deposition of cream of tartar to take place suggested at first the following process. Given a compound containing potassium, phosphoric acid, if present, could be separated as ammonio-magnesic, as tri-

calcic, or in any other convenient phosphate. The volatile acids could be driven off by excess of sulphuric acid and heat, until fumes of sulphuric acid began to appear. Sulphuric acid could afterwards be precipitated with acetate of barium, thus leaving acetic acid as the only acid in the solution, in combination with all the bases.

This process is simple in theory, but long and altogether detestable in practice. An analysis was already begun on this plan, when another much more simple and convenient suggested itself, which gave on trial the most satisfactory results. This process consists in adding to the compound to be analyzed, if it contains a strong mineral acid, a certain quantity of acetate of sodium and, afterwards, tartaric acid. The effect of adding acetate of sodium is that if a strong mineral acid is in excess, it forms a sodium salt by acting on the acetate, and liberates a corresponding quantity of acetic acid. When tartaric acid is afterwards added, and a quantity of acid tartrate is precipitated, the strong mineral acid set free reacts on the acetate, and acetic acid is again liberated. This action goes on until all the potassium has been precipitated as acid tartrate, and all the strong mineral acids, originally combined with potassium, have been combined with sodium, and a corresponding quantity of acetic acid has been set free.

The quantity of acetate of sodium that I usually add is equal to the quantity of tartaric acid. The theoretical quantity necessary is 55 per cent. of the quantity of the tartaric acid, but I always obtain excellent results by using equal quantities. The excess does no harm.

This action of acetate of sodium in promoting the precipitation of cream of tartar is one of importance in testing for potassium qualitatively. In our chemical books we find directions for precipitating potassium from its compounds by means of tartaric acid,

as if it was a difficult and delicate operation. An addition of acetate of sodium in conjunction with tartaric acid, and a discreet use of alcohol, will give indications of potassium in a few minutes, even when present in small quantities.

To give an example of analysis of potassium, let us take a sample of chloride and weigh 1 gramme. This is dissolved, and 2 grammes of acetate of sodium are added and dissolved. We now dissolve 2 grammes of tartaric acid and add them to the mixture of potassic chloride and acetate of sodium. We note the total volume of liquid, and, after the deposition of acid tartrate has stopped, we add about $\frac{1}{10}$ as much of alcohol of 93½ per cent., when a further deposition takes place. Afterwards the remaining quantity of strong alcohol is added, which must be such that the total volume of alcohol is double that of the original aqueous solution. The precipitated cream of tartar obtained is tested exactly as before, by a deci-normal solution of potassa.

Instead of estimating the precipitate of acid tartrate volumetrically, it may be dried at 100° C., and weighed.

The volumetric analysis is, however, preferable, apart from its rapidity and convenience, because by the action of alcohol some compounds, such as sulphates, may in certain cases be precipitated; but as they have not an acid reaction their presence would not interfere with the estimation by a titrated alkaline solution.

To enable me to verify the accuracy of the results obtained by this process of analysis, I have in all cases taken a stated volume of titrated solution of pure potassa, and I have added sulphuric, nitric, and hydrochloric acids, and varying quantities of sodium salts. The potassa dissolved to form a titrated solution was Tromsdorff's potassa by alcohol, containing no soda. The acids leave no residue by evaporation, and can therefore contain no potassium.

By saturating 10 c.c. of potassa solution with sul-

phuric, hydrochloric, and nitric acids, the following results were obtained. The numbers represent the c.c. of the same potassa olution which saturated the acid tartrate precipitated in each case:

SO^4K^2.	ClK.	NO^3K^2.
10.	10.	9.9
10.05	10.05	9.85
9.9	9.85	9.95

In making these experiments it was of the utmost importance that my solution of potassa should be pure, but in commercial tests it matters little whether the standard alkaline solution be of potassa or soda, as both neutralize cream of tartar.

The process for the estimation of potassium which I have described is not always advisable, as the strength of alcohol required may in some cases interfere with the results. When great many tests are to be made, as happens in a factory, and at the same time extreme accuracy is not required, the expense attending the use of so much alcohol may be worth consideration. For 1 gramme of substance weighed for analysis, 100 c.c. of strong alcohol are required, besides about 50 c.c. more for washing the precipitate. Altogether we may calculate that the alcohol for every test costs about 10 cents. In testing the low products of sugar-houses for potassium, strong alcohol cannot be used, because they contain substances which become adhesive and unmanageable in presence of strong alcohol.

To explain the process that I have used in such cases, let me take once more 10 c.c. of titrated potassa solution in a beaker glass, and add enough tartaric acid to precipitate the potassium. A certain portion will be deposited, but another part, although converted into cream of tartar, will remain in solution. If the precipitate is thrown on a filter without the addition of alcohol, and if we free it from excess of

tartaric acid by washing with water, a further loss will take place. If, instead of using pure water to dissolve the tartaric acid, added to our 10 c.c. of potassa solution, and to wash the precipitate of acid tartrate left on the filter, we use a liquid incapable of dissolving cream of tartar, the loss would be very much reduced. This we can easily do by using a saturated solution of acid tartrate. When the impurities on the filter have been removed by washing with this saturated solution, the last portion of this solution may itself be removed by washing with a small quantity of alcohol of 60 per cent.

There will then remain one cause of error, due to the water introduced with the 10 c.c. of titrated potassa solution, which may, with sufficient approximation, be considered as 10 c.c. of water. To estimate this quantity we must use the table of Chancel, already given, and, if we suppose that the temperature of the liquid is 25° C., we will find that at that temperature 100 c.c. of water will dissolve 67 centigrammes of acid tartrate, and therefore 10 c.c. will dissolve 67 milligrammes, corresponding to 16¾ milligrammes of potassa, and consequently to 0.85 of 1 cubic centimetre of deci-normal solution. If we have operated with care, we will find that we can account for the original 10 c.c. of potassa solution within $\frac{1}{10}$ of a cubic centimetre.

The results, however, are not nearly as accurate when salts of sodium are mixed with the potassa solution, and there is always a deficiency in the acid tartrate precipitated. I found, however, that a small quantity of alcohol will in great part overcome this difficulty, but by using too much alcohol, as much as 10 per cent., the results are too high. After a great many experiments, I have been led to adopt 8 per cent. as the strength of alcohol that gives the best results. The quantities of acid tartrate dissolved by 8 per cent. alcohol at various temperatures are as follows:

Temp. C.	100 c.c. of water, having 3 per cent. of alcohol, will dissolve cream of tartar, gr.,
0	0.21
5	0.25
10	0.32
15	0.37
20	0.45
25	0.54
30	0.60
35	0.75
40	0.84

This alcohol of 3 per cent., saturated with acid tartrate, is used to dissolve the potassium compound weighed for analysis, to dissolve tartaric acid and acetate of soda, to dilute our solutions, and wash our precipitates. As the temperature of a laboratory need not vary during an operation, no error need result from the quantities of cream of tartar which alcohol of three per cent. will take up at different temperatures.

Let us take a low sugar-house product to test for potassa, in the shape of a syrup of 42° Baumé. Suppose we take 100 grammes of this; the quantity of water in our weighed sample will be 20.6 grammes. To this we add a quantity of alcohol equal to 3 per cent., or 3.3 per cent. of alcohol, 98½ per cent., which is $\frac{1}{10}$ c.c. We may now dilute our syrup of 42° B. with alcohol of 3 per cent. until it is quite thin, and add about 5 grammes of tartaric acid, if the low product is from cane sugar, or about 20 grammes if a beet product. We should also add about the same quantity of acetate of sodium, and after allowing deposition to take place for about fifteen minutes, the precipitate may be treated as we have seen in other cases.

After the acid tartrate has been saturated by the titrated potassa solution, we should add to the result obtained by the burette the quantity of potassa corresponding to the acid tartrate dissolved by the 20.6 c.c. of water which accompany the 100 grammes

of 42° syrup, and the 0.7 c.c. of alcohol added, which are equal to 21.3 c.c., of alcohol, 8 per cent. If the temperature of the liquid at the time of filtration is 30° C., we will find in the table I have given that 100 c.c. of alcohol, 8 per cent., will at that temperature dissolve 60 centigrammes of cream of tartar, and consequently 21.3 c.c. will dissolve 13 centigrammes, which represent 32½ milligrammes of potassa, which should be added to the result.

The process based on the use of weak alcohol, saturated with cream of tartar, is of older date than the process I first described. The results obtained are not uniformly satisfactory, for, although they are generally good, sometimes there will be errors of 2½ or 3 per cent., which cannot be attributed to any cause that I could discover. These discrepancies induced me to try the other process, in which the solutions are made to contain 60 per cent. of alcohol, and this has always given satisfactory results.

XXI.—Proceedings.

Regular Meeting, Oct. 5, 1876.

The Society met at its rooms, in the University building, at 8½ P.M., Vice-President Chandler in the chair. The minutes of the last meeting were read and accepted.

The following report of the transactions of the Council of the Society, at its meeting of September 22d, was read and adopted.

The Corresponding Secretary, Prof. Barker, was requested to open correspondence, with a view of an exchange of publications, with those of the scientific societies of this country devoted to chemistry or supporting a chemical section, and with the chemical societies of Europe.

The Council proposed to the Society the following names for election as honorary members:

M. P. E. Berthelot, Robt. Bunsen, A. von Butlerow, St. Cannizzaro, J. B. Dumas, E. Frankland, A. W. Williamson, and Friedrich Wöhler.

The following were appointed a Committee of Arrangements for the Inaugural Address of Pres. John W. Draper:

Messrs. Morton, H. Draper, Egleston, Goldmark, H. C. Havemeyer, Schultz, Youmans, and Waller. It is expected that the address will be delivered on the 16th of November.

The committee on permanent rooms reported progress.

The Recording Secretary having tendered his resignation, on account of illness and prospective absence from the country, the Council recommended the non-acceptance of the resignation, and the appointment of Dr. Alsberg as Secretary pro tem.

The Nominating Committee, to propose to the Society nominations for officers and committees for the year 1877, were chosen as follows: Messrs. Chandler, Morton, Eastwick, Schultz, Nichols, and Froebel.

The following gentlemen were then elected:

Members.—C. A. Pitkins, A.M., Prof. Mariano Barcena, William Hodgson Ellis, Bruno Terne, Otto Wuth, S. A. Goldschmidt.

Associates.—W. R. Elmenhorst, Frederick W. Senff, James C. Baylis, P. Munziger.

The following names were proposed for election:

Members.—Prof. Henry Nelson Mertz, Willard S. Stanton, Prof. John F. Eastwood, Harvey W. Wiley, William McCree, Malvern W. Iles, Prof. Julian Grabowsky, Charles G. Dudley, Prof. Romyn Hitchcock, Prof. J. W. Langley, Prof. F. W. Clarke, Prof. Gustavus Hinrichs, E. H. S. Bailey, D. H. Melvin, Carl Pickhardt.

Associates.—Frederick Habirshaw, Rufus S. Merrill, Adolf Kuttroff, Wilhelm Pickhardt, Valentine Mott.

The first paper of the evening was read by A. Bourgougnon: "On the Quantitative Determination of Naphtha in Crude Petroleum."

The next paper was read by Prof. Grabowsky, of the University of Lemberg (Austria): "On Galician Ozokerite and Ceresine."

Papers by W. J. Land, Atlanta, Ga., were read: 1. "Mica Scale-Pans." "2. Determination of Carbonic Acid by Loss of Weight in the Apparatus."

A preliminary communication of Dr. Walz was read: "On Regularities of Color and Color Changes."

Vice-President Chandler announced to the Society the first death among its members, that of Prof. St. John.

Adjourned.

M. ALSBERG, *Secretary pro tem.*

XXII.—EXPLOSIONS AND METHOD OF TESTING PETROLEUM OIL.

BY R. S. MERRILL.

(Read July 6, 1876.)

Condensed Report by the Committee on Papers and Publications.

IN the early days of manufacturing petroleum little attention was paid to its fire-test, the aim of the manufacturer being to produce a large quantity of distillate which would burn freely, and the fractioning was so manipulated that the naphthas were allowed to mingle largely with the heavier and more fixed oils, thus rendering the whole product of very low fire-test.

The occurrence of frequent explosions and accidents from the use of such oils caused some of the manufacturers to change their system and separate the naphtha entirely from the oil, thus raising its fire-test

One hundred and ten (110°) degrees F. was selected, by general consent, as a standard of safety for the following reasons: cheapness, and the fact that in the lamps and burners in common use a high-test oil would not burn freely. The aim of nearly all inventions in both lamps and burners, for the last fourteen years, has been to produce appliances for burning the thin mobile oils of 110° fire-test, and, with but few exceptions, no efforts have been made to burn the safer oils of higher test. Many of the explosions which happen with an oil of 110° F. are attributed to accident or ignorance, rather than to the fact that an oil of this standard is always dangerous to handle. A lamp holding such oil is always in an explosive condition, if the temperature of the oil within has risen to 75° F. (always providing that the lamp be not entirely full, as some space for holding the mixture of vapor and air is necessary to an explosion).

My present object is to show by experiment the erroneous character of the general belief, that an oil is safe from explosion if not heated above its flashing point; this flash point is determined in the ordinary manner.

By the present method of testing, the flashing point is from 10° to 15° below the igniting point; but I have discovered, by the aid of an apparatus hereinafter described, that refined petroleum gives off an explosive vapor from 10° to 15° below the flash point, and from 25° to 30° below the burning point. These experiments will also show that there is a vapor eliminated from oil, when tested in an open vessel in the ordinary manner, which is so thin and light, that it is blown away from the surface of the oil and lost to recognition. These vapors, however are slowly collected in a lamp, and only await ignition to produce an explosion.

The accidents which occur are of two kinds: either the direct result of an explosion of the vapors, or

caused by breakage of the lamp, spilling, and consequent ignition of the oil.

It is not the explosion, but the invariably resulting ignition, in the case of all low-testing oils, which causes the damage. The manner in which the explosions are caused is not generally evident, since they occur suddenly and without due warning. They usually occur after the lamps have been burning for some time in a room, the temperature of which ranges from 70° to 80°. If the temperature of the room, however, is higher (100° or more), an explosion becomes impossible, since the vapors are given off in such quantities that the air becomes laden with an excess. This would not prove that such an oil was safe, as the spilling of the liquid, under such circumstances, would speedily show. While with whale or sperm oil a large amount of heat is necessary to generate, by chemical decomposition, any gases which will burn with a flame, in petroleum we find these gases or vapors ready formed, and prepared to ignite at low temperature, and burn so fiercely that nothing but absolute deprivation of oxygen will extinguish them.

The inflammability of naphtha and petroleum was there shown by setting fire to woollen dolls saturated with oils of various burning test—the one moistened with 150° fire-test oil requiring less than half a minute to ignite.

In the case of the oil, explosive vapors are also formed at a comparatively high temperature. This temperature is, however, some ten or fifteen degrees below its flashing point. To illustrate this the apparatus invented by Mr. S. S. Mann was employed, consisting of a water-bath, into which is set a common brass lamp similar to those used in factories. The burner of this lamp is replaced by a brass tube screwed into the collar, and closed by a rubber ball. Through the side of the lamp, near the top, a half-inch tube, with a valve opening inwardly,

and closing by the slightest pressure from within, is inserted. A thermometer is set in another brass tube. In this lamp is placed the oil to be tested. The tem-

perature of the oil is slowly raised by heating the surrounding water, and, during this process, the nature

of the vapors frequently tested by applying a flame to the opening in the valved tube. The exploding point of the vapors will then be shown by the rapid expulsion of the rubber ball from the neck tube of the lamp. By means of this apparatus I am thus enabled to show that 150° oil will explode at 115°, and 110° oil at 75°.

In conclusion, I should consider the flash-test to be of far more importance than the fire-test, and that it should be fixed at not less than 140° F. Such oil, which, when lighted, will burn freely, is not easily ignited, and will certainly never explode at the average temperature of dwelling-houses.

XXIII.—Quantitative Determination of Naphtha in Crude Petroleum.

BY A. BOURGOUGNON.

(Read Oct. 5, 1876.)

In my last communication I endeavored to prove that a correct analysis of crude petroleum requires a fractional distillation made in one-hundredth parts. Such a distillation requires from seven to eight hours, and in the commercial practice of inspecting crude oil, when several samples are brought at the same time, it is nearly impossible to give so much time to a distillation.

In all cargoes of crude oil samples of every five hundred barrels are to be distilled, which is the average amount of oil shipped daily. Being convinced that the fractional distillation in one-hundredth parts is not always practicable, I have tried to shorten the analysis.

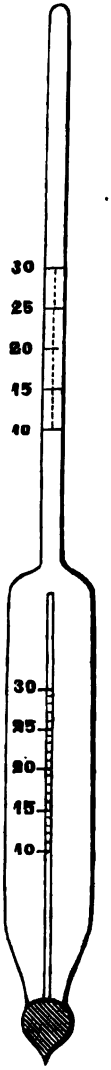
One of the essential points to bring to the knowledge of the buyer in all transactions of crude petroleum is the determination of naphtha contained in it, as the crude oil is taxed in foreign custom-houses according to the quantity of naphtha it contains.

To determine the percentage of naphtha, I will suggest the following plan, earnestly asking your criticism; but I will add that for my part, although having obtained a result agreeing with that obtained by fractional distillation, I consider this process inferior to the fractional distillation in one-hundredth parts.

I employ an instrument made on the same principle and of the same shape as the densimeter, which I call *naphtometer*.

To make the graduation of this instrument, I proceed as follows:

The specific gravity of commercial naphtha being 0.700 at 15° C., it is first necessary to have such naphtha. This naphtha being at the temperature of 15° C., the naphtometer is immersed in it, and on the stem, at the point of intersection with the liquid, the number 15 is written. The same naphtha is brought to the temperature of 20° C., and on the stem as above, the number 20 is written; the temperature of the naphtha is again increased to 25° C., and the number 25 is written on the stem at the point of intersection; and so on, in order that the temperature indicated by the thermometer (when immersed in naphtha of 0.700 at 15° C.) will be always in accordance with the figures marked on the stem—for example: if I have a sample of naphtha of which the density is 0.700 at 15° C., but supposing that the actual temperature be 20° C., the naphtometer will indicate 20, both by the thermometer and on the stem at the point of intersection with the liquid.



Now, to determine the percentage of naphtha in crude petroleum, I distil a

known volume of crude oil, say 300 cubic centimetres, and receive the product of distillation in a cylindrical glass vessel divided in cubic centimetres, in which glass the naphtometer has been previously placed. The temperature of the product distilled is noted, and if, *e. g.*, the temperature be 25° C., the distillation is continued until the point marked 25 on the stem intersects with the liquid. At this moment the naphtha obtained has a specific gravity of 0.700 at 15° C., as I have verified by several experiments.

Removing the naphtometer from the jar, cooling to 15° C., and reading the number of cubic centimetres obtained and dividing by 3, I obtain finally the percentage of naphtha at 0.700 density and at the temperature of 15° C. contained in the crude oil.

XXIV.—On Galician Ozokerite and Ceresine.

BY DR. J. GRABOWSKY.

(Read Oct. 5, 1876.)

Ozokerite is found in Galicia (Austria) principally in Borislaw near Drohobycz, and Dzwiniacz near Stanistawow. Both places are situated at the northern foot of the Carpathian mountains; the formation is miocene, and of some importance on account of its petroleum springs. The production of "earth-wax" (ozokerite) was estimated to have amounted to about twenty million of kilogrammes in 1875, upwards of eighteen million of kilogrammes coming from Borislaw alone. According to F. v. Hauer, the largest crystals of salts, which are found in connection with the ozokerite, as well as the saline springs in the petroleum-bearing strata, prove that these latter belong to the zone of the calcareous neogene formation. They contain the fluid oil as well as the solid "earth-wax" partly in more or less regular beds, partly in fissures and pockets. The exploitation is effected by means of shafts and tunnels,

the former being from 40 to 80 metres deep and about 1 metre square, the latter being generally quite short on account of the very primitive method of ventilation and the great amount of gases. The shafts generally pass, first, through 8 to 10 metres of gravel mixed with boulders, then, through blue loam and plastic clay, which contains numerous layers of marl, slate, and sandstone. In this clay, usually at a depth of from 40 to 50 metres, petroleum springs and ozokerite are found. This latter forms lumps or layers from 1 to 3 feet thick, these lumps sometimes weighing several hundred kilogrammes. This native ozokerite is transparent, of pure honey-yellow color, possessing the hardness of common beeswax. More frequently, however, ozokerite is found in thin layers and small pieces, which must be separated from the gangue; the smallest pieces are only obtained by a process of washing.

Besides pure, good "earth-wax," some varieties occur which are especially distinguished by hardness and color.

The best "earth-wax" should have a pure yellow or greenish color, and be easy to knead between the fingers; this, after having been tried (melted), yields a "prime" earth-wax, which is generally used for the manufacture of "ceresine." The poorer kinds are colored black, and either very soft (containing much petroleum), or too hard, resembling asphaltum, fusing at a high temperature. After trying, these produce an "earth-wax" which is chiefly used for the manufacture of paraffine.

Occasionally there are found pieces of ozokerite, which is very compact, as hard as gypsum, fuses above 100° C., and is dichroitic (dark green in reflected and pure yellow in refracted light).

The composition of ozokerite is best expressed by the formula C_nH_{2n}. Very little is known about its formation. It appears to me to be very probable that it

has to be considered as a product of the oxidation and condensation of petroleum hydrocarbons. Only lately we have seen that hydrocarbons, as, *e. g.*, naphthalene can form by oxidation not products containing oxygen, but dinaphthil:

$$2C_{10}H_8 + O = C_{20}H_{14} + H_2O.$$

By supposing a similar oxidation of hexan or octan, we obtain compounds of the formula C_nH_{2n}, which again may condense with hydrocarbons of the marsh-gas series, and thus give rise to the formation of very complicated hydrocarbons of high melting-point, *e. g.*:

1. . . . . $2C_6H_{14} + O_2 = C_{12}H_{26} + 2H_2O.$
2. . . . . $C_{12}H_{26} + C_6H_{14} + O = C_{24}H_{48} + H_2O.$

By this hypothesis the formation of petroleum may be reduced to an oxidation of marsh-gas, and thus the close connection between ozokerite, petroleum, and coal be explained in the most simple manner.

As stated above, the crude ozokerite is separated rom the gangue by melting, and worked into paraffine or ceresine. The trying is effected either by direct fire or by steam. In the former case, the ozokerite is placed into iron kettles of about one and a half metre in diameter by one metre in height, melted, drawn off, and the residue boiled with water, when all the ozokerite will rise to the surface of the water; In the latter case, the melting is done by steam in the same manner as with paraffine or stearine, and needs no further description. The tried ozokerite is clarified by allowing it to settle for several hours, and then poured into iron moulds. It is shipped in this form, without any further packing, and in pieces of about fifty to sixty kilogrammes.

There are, principally, two kinds of commercial ozokerite: prime and second. Prime "wax" ought to be as free as possible from earthy impurities, and in small transparent, greenish-brown to yellow pieces; the lighter in color and the more transparent, the better

it is. "Second wax" is dark brown, almost opaque, occasionally containing a great deal of earthy impurities, and is generally much softer than the prime. Both are used for the manufacture of either paraffine and illuminating oils, or ceresine. The manufacture of paraffine from ozokerite is effected by distillation over direct fire, from iron retorts with flat bottoms containing from 700 to 1,000 kilogrammes. The products of the distillation are:

Benzine	2 to 8 per cent.
Naphtha	15 " 20 "
Paraffine	36 " 50 "
Heavy (lubricating) oils	15 " 20 "
Coke	10 " 20 "

The paraffine is pressed, treated with sulphuric acid and caustic soda, filtered through paper and fine animal charcoal, and manufactured into candles. The naphtha is purified in the usual way, and the heavy oils are sometimes subjected to fractional distillation, but mostly shipped as such to Vienna.

The manufacture of ceresine consists of the removal of the impurities from the "earth-wax" by the aid of sulphuric acid and animal charcoal; but only the best kinds of ozokerite are used. The different processes are kept secret, and are also protected by patents. In general, the ozokerite is melted with concentrated sulphuric acid and the residue from the manufacture of yellow prussiate, pressed, treated again with prussiate residue, and filtered. 100 parts good prime "earth-wax" yield 60 to 70 parts white wax, which in its properties very closely resembles white beeswax, and is called "ceresine." It is either further purified by repeated treatment with acid and prussiate residue, or colored with gamboge or alkanet, and thereby made to closely resemble common beeswax. In the manufacture of ceresine only sulphurous acid and press residues are obtained, the former of which escapes into the air, but

might be utilized, thus reducing the cost considerably. The consumption of sulphuric acid in Borislaw alone is said to amount to one million kilogrammes a year. The prussiate residues are obtained from the lixiviation of the crude prussiate in Moravia.

The finely divided animal charcoal seems to be the active agent, since a fair ceresine may be obtained by simply treating commercial "earth-wax" with bone char and concentrated sulphuric acid.

Comparatively only a small quantity of earth-wax is worked in Galicia; it is shipped principally to England, Moravia, and Vienna. The ceresine is exported in large quantities to Russia, where it is sold as beeswax; for this purpose it is melted together with a little beeswax, in order to impart to it the characteristic odor. Good ceresine is hardly to be distinguished from beeswax; the best methods are the following:

1. Ceresine is not as easily kneaded between the fingers, and becomes brittle more readily than beeswax. This test is, however, doubtful, if the sample consists of a mixture of the two.

2. Ceresine is scarcely attacked by warm concentrated sulphuric acid, whereas beeswax is completely destroyed by it. By this test the quantities of beeswax and ceresine can be determined in a mixture of both.

In many cases ceresine can be employed in the place of beeswax. It is sold at from 32 to 40 dollars per 100 kilogrammes in Vienna, whereas the price of the commercial earth-wax varies from 10 to 12 dollars per 100 kilogrammes.

The whole exploitation of the ozokerite, on account of the want of enterprising men, is in the hands of the Jewish population. It is very imperfect, and necessarily requires many changes in the mining laws.

XXV.—Mica Scale-Pans.

BY WM. J. LAND.

(Read October 5, 1876.)

Our best analytical balances of 200 grms. capacity are usually fitted with a pair of movable glass pans, or watch-glasses of three inches diameter, and weighing about *thirty grammes*. To relieve the delicate bearings of the instrument from this unnecessary weight, and also to *increase the capacity* of the same in a commensurate degree, I employ as a substitute for these glasses a pair of three-inch *mica disks*, which weigh less than *two grammes*, the "gravity bob" if necessary being adjusted to this change. After three years' daily use, I find these mica pans as good as at first. The abrasion of the mica surface by a platinum spatula (used in weighing) during this period is scarcely visible. The mica used for this purpose is a pure, hard article found in North Carolina. It is as clear or transparent as flint glass when split sufficiently thin for the purpose to which it is here applied. Another great advantage of the mica is found in its *flexibility*, which enables one to dispose of weighed material with rapidity and exactness, as by bending the mica into a semi-cylindrical form it can be adapted to the mouth of a flask, crucible, etc., with the greatest ease.

Small discs of this material also form excellent *transparent covers* for platinum crucibles and capsules, where the heat applied does not exceed low redness, as in the conversion of oxalate into carbonate of lime, etc. I feel confident that no member of this Society will ever abandon the use of mica scale-pans, after a thorough trial of the same.

Atlanta, Sept. 9, 1876.

XXVI.—Determination of Carbonic Acid by Loss of Weight in the Apparatus.

BY WM. J. LAND.

(Read Oct. 5, 1876.)

The several forms of apparatus which have been devised by *Drs. Will Fresenius, Rose, Geissler*, etc., for the determination of *carbonic acid* by loss of weight in the apparatus from which it has been expelled by one of the stronger acids, seldom give constant or very close results—owing principally to the *escape of steam, hydrochloric acid, etc.*, with the gas, while *aspirating the* HOT apparatus. The liquid remaining, after the expulsion of the gas by a stronger acid, is brought to a boiling temperature to drive off the last traces of the gas; and to prevent the re absorption of the latter, we are directed to aspirate the apparatus while *hot*, thus causing more or less loss of steam (and some of the stronger acids) even where a long drying tube is attached.

I have recently devised a very simple and effective method, whereby the carbonic acid, after its expulsion from the liquid by heating, is *prevented from coming again in contact with it*, thus avoiding *reabsorption, as also allowing the apparatus to cool before aspiration is performed.*

This method requires no new form of apparatus, but simply the introduction of a *lump* of *paraffine* with the weighed carbonate, the paraffine being afterwards weighed as a part of the apparatus.

In bringing the liquid to the boiling-point, as usual the paraffine melts and covers the form of the liquid, forming a *perfect protection against reabsorption of the gas by the liquid*, which is now left *undisturbed to cool*, after which aspiration may be safely performed.

When the final weighing is made, the crust of paraffine is broken, or pierced in several places by a glass

rod, and *well washed*, allowing it to remain in the apparatus (indefinitely) for future experiments. I modify the *drying tube* by adding fragments of pumice-stone previously saturated with cupric sulphate solution, (and well dried) to absorb any traces of hydrochloric acid which may be carried over. This pumice is put into the *drying-tube* with an equal quantity of chloride of calcium—separating the two by a lock of cotton wool or asbestos. A number of carbonic acid determinations upon *calc-spar* (using HCl) gave results varying less than 0.08 per cent., while the original apparatus with *hot* aspiration (and careful experiments) gave results varying as much as 0.40 per cent.

The paraffine is also excellently adapted to preservation of other solutions, as proto-salts of iron while making iron determinations, *Pattinson's manganese determinations* by proto-sulphate of iron, etc. The *solid* form of the paraffine gives it an advantage over liquid hydrocarbons, even if they be sufficiently stable and non-volatile to substitute it; as in the CO_2 apparatus, most of the gas can be *expelled before the paraffine melts*, which expulsion would be more difficult if the fluid was previously covered by a fluid hydrocarbon.

ATLANTA, Sept. 9, 1876.

XXVII.— On Some Regularities of Color and Color-Changes.

Preliminary Notice.

BY ISIDOR WALZ, PH.D.

(Read Oct. 5, 1876.)

As far as I am aware, E. J. Houston * was the first to announce the law that the changes of color which certain substances experience under the influence of heat, follow a certain order, viz.: *the order of the colors*

* Journal of the Franklin Institute, Oct., 1871.

of the solar spectrum. The subject has since received further attention,* and the terms *metachromatism* and *thermochromatism* have been proposed wherewith to designate this class of phenomena.

I desire to place on record here, in a preliminary note some observations which I have made in a similar direction. While engaged in studying the phenomena of solubility in connection with the specific volumes of substances,† I repeatedly found what I believed to be clues pointing to a connection between other physical properties of substances (such as volatility, etc.) and their specific volumes, of which none interested me more than those relating to the color of substances. I have since continued to follow up this subject, and believe to have undoubtedly demonstrated certain regularities; but since my material is still incomplete, while at the same time my health compels a suspension of labor for a considerable time to come, I trust to be excused for presenting an incomplete report of my work.

The law that "substances change color in the order of the spectrum colors under the influence of heat," I believe to be far more general, *the same order being observed in a large number of reactions in which color-change is induced by chemical action.* If any one will take the trouble to examine, *e.g.*, the color-reactions of the alkaloids in Dragendorf's Gerichtlich-Chemische Ermittlung der Gifte (p. 235 *et seq.*), he will readily concede this. I will only instance the color-change of veratrine with pure sulphuric acid, viz.: yellow, orange, blood-red, crimson. As a remarkably striking example, however, I will select Adam Kiewicz's color-reactions of albumen, as described by himself.‡ In pure concentrated sulphuric acid, albumen dissolves with a definite color. If we add to this acid in a

* W. Ackroyd, Chem. News, xxxiv., p. 75.

† Am. Chemist, Feb., 1875.

‡ Pflueger's Archiv für Physiologie, X., 156.

test-tube dilute egg-albumen drop by drop, while agitating the same cautiously, the solution of the albumen is effected, attended by a color-change that commences with green, and ends with a deep violet. Green is changed in the first place to yellow, the yellow runs through its several stages of saturation, passes into orange and finally into red, from which the color scale follows various shadings down to dark cherry-red. The color-change ends at last in a deep violet, which forms the terminal reaction of the albumen solution in sulphuric acid. Farther on the author gives the following tabular statement, when sulphuric acid of 1.8095 sp. gr. is used.

Abumen-Sulphuric Acid.

Percentage of Albumen,	1.5	7	15	22
Color of the Solution:	Green,	Yellow. Orange.	Red.	Violet.

One great difficulty in the pursuit of a research on color is the varying designation of the color of the same substance by different writers, *e.g.*, the use of purple and violet as synonymes, although purple (as well as crimson) belongs to the red end of the spectrum, and violet to the other extreme.* The detailed description of the color-change in red, in the above reaction, fully justifies us in substituting the word purple for the violet used by the author, thus making the series absolutely perfect, viz.:

Green, Yellow, Orange, Red, Purple.

As another example of a color-change in the order of the spectrum colors, induced by chemical action, but in the inverse order, I cite from the following reaction of vanadic acid.† "If the *dark red* solution of vanadic acid, prepared with boiling sulphuric acid and diluted with fifty times the quantity of water, is gently warmed with zinc, the vanadic acid passes successively under *blue* coloration into tetroxide, under

† Compare Helmholtz, Physiol. Optik., p. 237.

‡ This description is taken from Jahresber. für Chemie, 1867, p. 241.

green coloration into trioxide, and lastly under *violet*, or *lavender-blue* coloration into dioxide." The series here is only interrupted by the appearance of the blue before the green color, a phenomenon which also occurs in other series, and on the cause of which I hope further research will throw some light. On the other hand, the description, or "lavender-blue," leaves us no doubt that violet is here used in its proper sense.

The allotropes of phosphorus offer an interesting case of color-change *in spectrum order with increasing density*.

	Phosphorus.			
Color,	White.	Deep Red.	Orange-Red.	Violet-Gray.
Specif. Gravity,	1.836	2.148	2.19	2.293
	Pisati and DeFranchis' at 0° C.	Determined by Troost and Hautefeuille at 0° C.		

Designating the color of iodine and its vapors as purple (which may be justified, I think, by the color of its solutions in solvents that tend to red and brown, but not to violet, by the diathermancy of its solution in carbon disulphide to the ultra-red rays, etc.), we have in the well-known halogen group an instance of *color progressing in spectrum order in a group of analogous substances*, viz.:

Chlorine.	*Bromine.*	*Iodine.*
Greenish Yellow.	Red.	Purple.

The solutions of sulphur, selenium, and tellurium show a similar color-series. Instances of this kind are quite numerous among compounds. Taking, *e.g.*, the chlorine, bromine, and iodine compounds of lead, silver, and mercury, we shall find the iodides nearer the red end of the spectrum in color than the bromides, and the latter nearer than the chlorides. In a similar manner the sulphides of many metals are colored, while the corresponding oxides are colorless, *e.g.*, the metals of the alkalies and alkaline earths. Again, taking

series of oxides, chlorides, etc., of one and the same element, we also frequently meet with this regular progressive variation of color, the latter *generally, but by no means always, shifting from the violet to the red end of the spectrum, as we rise in the series*—subject, however, to anomalies, such as the apparent transposition of two contiguous colors. Thus, according to Berzelius (Handbuch, s.v.), ferrous oxide, in oxidizing, passes through the following series of colors: gray, *green*, *dark blue*, yellowish brown. (Here we find again the blue and green transposed, as it were, as in the case of the vanadic oxides quoted above. This particular anomaly would seem to be quite frequent.) The compounds and salts of iron, manganese, chromium, uranium, vanadium, etc., furnish numerous instances in which this regularity may be traced.

The above facts may suffice for the present. I hope to be able to prove, by a fuller presentation at some future time, that *when a series of color-changes is imitated by chemical action, the colors appear successively in the order of the spectrum; that when, as in phosphorus, the color of a substance changes with its physical condition, the changes occur in the order of the spectrum, progressively with the change of physical properties, such as density, specific volume, etc.; and that in series of colored compounds of analogous or similar atomic constitution, the colors are in the order of the spectrum*, generally, as I believe at present, passing from the violet to the red end as we rise in the series. There is abundant cause, in my opinion, for the belief that the color of a substance is intimately connected, not only with the chemical constitution, but also with the physical constants (density, specific volume, molecular weight, etc.), of its molecules; and possibly we may yet arrive at a knowledge of the actual dimensions of the molecules of colored substances by data obtained from the wave-length corresponding to the colors which they transmit or reflect.

THE

AMERICAN CHEMICAL SOCIETY.

XXVIII.—PROCEEDINGS.

Regular Meeting, November 2, 1876.

THE meeting opened at 8.15 P.M.—Vice-President Chandler in the chair.

The minutes of the last meeting were read and accepted. The Committee on the Inauguration reported that arrangements had been made to engage Chickering Hall for the evening of November 16, 1876, at which time the inaugural address of Prof. J. W. Draper, on "Science in America," would be delivered.

A motion was made and adopted that the distribution of tickets be left to the Committee.

The Committee on Nominations reported through its chairman, Dr. Schultz; and after some discussion the following ticket was nominated:

For President—J. Lawrence Smith.

For Vice-Presidents—C. F. Chandler, Henry Morton, Silas H. Douglass, Charles A. Goessmann, T. Sterry Hunt, S. W. Johnson.

For Corresponding Secretary—George F. Barker.

For Recording Secretary—I. Walz.

For Treasurer—W. M. Habirshaw.

For Librarian—P. Casamajor.

For Curators—E. Sherer, W. H. Nichols, F. Hoffmann.

For Committee on Papers and Publications—H. Endemann, E. Waller, W. Shapleigh.

For Committee on Nominations—E. P. Eastwick,

Charles Froebel, H. C. Havemeyer, J. Goldmarck, Henry Draper.

The following were elected by ballot:

Members—H. W. Mertz, Wheeling, W. Virginia; Willard S. Stanton, Haverhill, Mass.; J. F. Eastwood, Bethany, W. Va.; H. W. Wiley, Lafayette, Ind.; William McCree, Del Norte, Cal.; M. W. Iles, Baltimore, Md.; J. Grabowsky, Lemberg, Austria; C. B. Dudley, Altoona, Pa.; R. Hitchcock, Chicago, Ill.; F. W. Clarke, Cincinnati, Ohio; E. H. S. Bailey, Bethlehem, Pa.; C. Pickhardt, New York.

Associates—F. Habirshaw, New York; A. Kuttroff, New York; W. Pickhardt, New York; Valentine Mott, New York; R. S. Merrill, Boston, Mass.

The following were proposed as members:—W. Wheatley, New York; Wolcott Gibbs, Cambridge, Mass.; J. C. Booth, Philadelphia; C. L. Jackson, Cambridge, Mass.; A. P. Aitkin, Edinburgh, Scotland; William Ashburner, San Francisco; E. H. Secour, New York; P. T. Austen, Stapleton, Staten Island; O. A. Moses, Charleston, S. C.; D. H. Cochran, Brooklyn, N. Y.

The first paper of the evening was read by Dr. H. A. Mott, Jr., on "Artificial Butter." Mr. P. Casamajor read the second paper on "A New Portable Burette."

The following papers were read by title and ordered to be printed:

"On the Determination of Phosphorus in Pig Iron by Means of Molybdic Acid," by F. A. Cairns, A.M.

"On Alcohol in Statu Nascendi," by H. Endemann, Ph.D.

Adjourned.

M. ALSBERG,
Rec. Sec. pro tem.

DR. J. W. DRAPER.

XXIX.—Science in America.

Inaugural Address of Dr. John W. Draper,

As President of the American Chemical Society. Delivered in Chickering Hall, New York, November 16, 1876.

Gentlemen, Members and Associates of the American Chemical Society:—In accordance with the plan of the American Chemical Society, I am called upon to address you this evening. I have to congratulate you on its successful establishment, and its prospect of permanent success.

Let us consider some of the reasons which would lead us to expect that success, not only for our own, but also for other kindred societies. The field of nature is ever widening before us, the harvest is becoming more abundant and tempting, the reapers are more numerous. Each year the produce that is garnered exceeds that of the preceding. In all directions there is good hope for the future. Perhaps, then, you will listen without impatience for a few minutes this evening to one of the laborers who has taken part in the toil of the generation now finishing its work, who looks back not without a sentiment of pride on what that generation has done, who points out to you the duties and rewards that are awaiting you, and welcomes you to your task. Let us look at the prospect before us.

The progress of science among us very largely depends on two elements: First, on our educational establishments. Second, on our scientific societies. To each of these I propose to direct your attention. And, first, of our colleges:

Prof. Silliman, in his address, delivered on the occasion of the Centennial of Chemistry, at the grave of Priestley, in commemoration of the discovery of oxygen, makes this remark: "The year 1845 marks

the beginning of a new era in the scientific life of America, which is still in active progress, and chemistry has had its full share in this advance." He then enumerates the causes which, in his opinion, had brought about this increased activity. Among them are the Centennial celebration of the American Philosophical Society in Philadelphia in 1843; the reorganization of the United States Coast Survey in 1845; the establishment of the Smithsonian Institution at Washington in 1846; the enlargement of The American Journal of Science in the same year; the contemporaneous foundation of the Astronomical Observatory at Cincinnati; the institution of the Analytical Laboratory at Yale College in 1847, and simultaneously the Lawrence Scientific School at Harvard. To these he adds especially the establishment of the American Association for the Advancement of Science in 1848. Coinciding with him fully as to the character and power of these and other local causes which he mentions, I cannot but regard them as being themselves the issues of influences of a much more general kind.

A revolution had been taking place in Europe—a revolution not so much political as industrial and social, though it was followed by political consequences of the most important nature. Its commence ments may be seen in the preceding century in the canal engineering of Brindley; in the improvements of iron manufacture; in the construction of all kinds of machinery, which reached its acme when the hand of man was deposed from its office, and through the slide-rest and planing machine engines were made by themselves. Then came the exquisite contrivances for the manufacture of textile fabrics, so that a man could do as much work in a day as he had formerly done in a year, the movement in that direction culminating in the two steam-engines, the condenser and non-condenser. The demand for cotton rose; the value of the slave, its cultivator, was enhanced; and the negro

question became the paramount political question in the United States. See how scientific discoveries and inventions lead to political results! Herein, among other great events, we find the origin of the American civil war.

In Europe, the social effect of the use of steam was strikingly marked. Performing mechanical drudgery, it relieved vast numbers of the laboring class, and gave them time to think. It concentrated them in factories and mills. Those industrial hives were pervaded by literary influences, perhaps not always of a kind that we should approve of. They became the seats of agitation in politics and theology, and while this was the effect on the laboring mass, the owners or capitalists were accumulating enormous fortunes.

We may excuse the enthusiastic literature of the cotton manufacture its boasting, for men had accomplished works that were nearly godlike. Mr. Baines, writing in 1833, states that "the length of cotton yarn spun in one year was nearly five thousand million of miles—sufficient to pass round the earth's circumference more than two hundred thousand times, sufficient to reach fifty-one times from the earth to the sun. It would encircle the earth's orbit eight and a half times. The wrought fabrics of cotton exported in one year would form a girdle for the globe, passing eleven times round the equator, and more than sufficient to form a continuous sheet from the earth to the moon." And let us not forget that to give commercial value to this vast result the capital chemical discovery of bleaching by chlorine was essential. Such was the condition of things in England just previously to the epoch in question. Necessarily it was followed by great social results.

But there was something more. The locomotive absolutely revolutionized society. A man could now travel further in an hour than he had previously done in a day. Again it was clear that important political

results were occurring. The effect of the railroad was to render nations more homogeneous, to destroy provincialism. It is actually true that language underwent a change. No one who had remarked the various dialects of the English counties prior to the opening of the Liverpool and Manchester Railway, and the homogeneousness of speech which is fast displacing them, could be blind to this. Simultaneously a redistribution of the population took place. It was largely withdrawn from the open country, and concentrated in the towns.

In this statement I am recalling facts so common that they are familiar to us all. We all appreciate the immense social changes that took place just before 1845. Who in those times could fail to perceive that grand consequences must follow the expenditure of thousands of millions of dollars in the building of railroads, who, when he saw the labor of a year shrinking into the compass of a day, the travel of a day into the compass of an hour, the thought of man outstripping the velocity of light, who could be so obtuse as not to discern that a new agency had taken possession of the earth, that it was agitating the nations to their very foundations, that it was ameliorating the lot of man, increasing his power, and dealing remorselessly with old ideas, the fictions and fallacies of the past!

Can we wonder, then, that those who were growing up in the midst of these marvels should not only contrast the activity by which they were surrounded with the stagnation of preceding centuries, but should demand to be made acquainted with the power that was thus opening a new world before their eyes. Very soon it became apparent that there was no provision in the existing educational establishments, the universities and colleges, for this unexpected state of things. These were, to be sure, good enough to initiate a bench of boys into the method of translating

an ode of Horace or a few lines of Sophocles, but omething more substantial than that was wanted now.

This was the true cause of that influence which began to be felt in America about 1840. Every reflecting person saw that a change in public education was imperative—nay, more was impending. Confronted by the vigor of modern ideas, the system that had come down from the dark ages was seen to have become obsolete.

In addition to these influences, there was another, at which we must for a moment glance. Let me, in a few words, sketch its history.

The peninsula of Italy was separated from the rule of the Greek emperors, in the eighth century, mainly in consequence of the iconoclastic dispute. Partly through the stress of circumstances, and partly as a matter of policy, the Latin language was brought into such prominence that it was supposed to contain all the useful knowledge in the world. In Western Europe, at the close of the fourteenth century, Greek was totally forgotten.

But when it became clear that Constantinople would be taken by the Turks, many learned men fled to the West, bringing with their language precious classical manuscripts. As it was feared, however, by the dominant authority that knowledge and opinions of an unsuitable kind might thus be introduced, Greek obtained a foothold with much difficulty, and it was only by the aid of Florence, Venice, and other commercial towns of Upper Italy, that after a struggle it made good its ground. The Latin had now a successful rival.

A century later brings us to the culmination of the Reformation. Its literary issue was an admiration of the language of that much enduring, that immortal race to whom the Old Testament is so largely due. As had been the case with Greek, so now Hebrew passed

from a condition of neglect to one of extravagant exaltation. It was believed to have been the original language of the human race, a conviction that proved to be a great stumbling-block to the progress of learning. There were thus three classical languages, each having its own paramount claim.

In 1784 the Royal Asiatic Society was instituted in Bengal. One of its earliest and most important services was that it brought the Sanskrit language emphatically to the knowledge of Europe. The similarity of this to Latin and Greek, especially in the grammatical forms, struck every one with surprise. At first the old literary party resisted its claims, some of them even affirming that it never had been a spoken tongue, but that it had been fictitiously constructed out of Latin and Greek. The creation of comparative grammar by the great German scholar Bopp, in 1816, threw a flood of light on the subject, and the discovery in 1828 by Hodgson of the Buddhistic sacred writings in Nepaul revealed to astonished Europe a literature of grand antiquity and prodigious extent, in which is contained the religious belief of 400,000,000 of men—ten times the present population of the United States. Greek and Latin had now to descend from the imperial thrones on which they had been seated, and take their places as later and less perfect forms of this wonderful Oriental tongue.

In the higher regions of literature all over Europe these discoveries made a profound impression. It was at once seen by the great scholars of the times that the existing educational system, founded as it so largely was on the languages of the Mediterranean peninsulas, was altogether on an imperfect basis. They saw that philology was about to occupy a higher platform, and that, though it might cost a struggle with present interests, a change in public education was necessary. But though these languages have suffered an eclipse, there still remains that priceless

heritage which they have transmittted to us—immortal examples in national life, in patriotism, in statesmanship, in jurisprudence, in philosophy, in poetry. Still there remain the ruins of the Parthenon, the relics of statues which have no rival elsewhere in the world—embodiments of the beautiful, before which, even at the risk of being denounced as a pagan, a man might fall down and worship. Still there remains the history of that awful empire which once bore sway around the Mediterrannean Sea, an empire to which we owe our civilization, our religious convictions, and even our modes of thought.

I add this great discovery in letters to the scientific and industrial movement I have described as bringing on the epoch of 1840.

Educational institutions are in their nature very much under the influence of the past. They are guided by men of the parting generation, and are essentially conservative. The changes they began to manifest did not originate within them, but were forced upon them from without. They clung to the mediæval as long as they could, and only accepted the modern when they were compelled.

Among American colleges which are emancipating themselves from the mediæval we may number Columbia, Cornell, Harvard, Princeton, Yale, the Universities of Pennsylvania and Virginia. Doubtless there are many others that would follow the example, if they could, but they are fettered with the gyves of sectarian or local restraint. They march along, daintily and grotesquely, in the pointed shoes of the fourteenth century.

I linger on this subject of colleges because the example of other countries, and especially of Germany, proves to us that on them our hopes for the development of science must very largely rest. The scientific glory of Germany, not inferior in brilliancy to its military glory, is the creation of its university professors.

Among them we find the great chemists and physicists, whose works we study with delight.

Our colleges must separate themselves from the mediæval, and assume thoroughly and sincerely the modern cast. Sincerely, I say, for not a few of them indulge in deception. They would have us believe that they teach physics when they have no modern apparatus; chemistry when they have no laboratory; botany without any garden, herbarium, or even drawings; geology, mineralogy, natural history, without any cabinets. So ignorant are some boards of trustees and faculties that they hold such equipments as luxuries easily dispensed with. I have known some go so far as to affirm that as much money ought to be expended in teaching a few boys Latin and Greek as in giving a demonstrative and illustrated course of science, and even to act on that principle. In institutions under this kind of influence you will always find that their whole weight is thrown towards the æsthetic. Whatever college honors there may be, whatever emoluments, pass in that direction; and though through fear of public opinion science cannot be ignored, it is simply tolerated, not cultivated.

From our colleges we may, in the second place, turn to our scientific societies.

I have referred to the period at which the Greek language became cultivated in Western Europe. The first societies were those established in Florence by its admirers. In the Medicean gardens the lovers of Plato assembled to restore, under an Italian sky, the philosophy that had been extinguished in Athens, and to commemorate by a symposium the birthday of that illustrious man. There is a pleasure in associating with those whose thoughts are congenial to our own, in breathing an atmosphere in which the intellectual makes itself felt.

Very soon the example was imitated. Persons who

had a love for science followed the example of those who had a love for letters. The Academia Secretorum Naturæ was instituted at Naples, in 1560, by Baptista Porta, the inventor of the camera, which photographers now so much use; the Lyncean Academy for the Promotion of Natural Philosophy, in 1603; the Royal Society of London, 1645; the Royal Academy of Science in Paris, 1666; the Berlin Academy of Arts and Sciences, in 1700. Leibnitz, the rival of Newton was its first President.

When the Royal Society of London was founded, it encountered a bitter opposition. Had it not been for the "Merry Monarch," Charles II., it must have succumbed beneath the fierce maledictions launched against it.

As in Italy, when the opportunity was offered, men of the same inclination of thinking sought each other, so here, to the surprise of the most enthusiastic chemists, when such an association was proposed persons seeking membership came crowding in. The society I have the honor of addressing this evening was the result. Already it has completely organized itself; already it has published the first number of its "proceedings," a publication which I am sure will procure for it approval and respect.

In these organizations of scientific effort an opportunity of assisting is given to those who, not having dedicated themselves to philosophical pursuits, have yet achieved success in other walks of life, and who, recognizing that the progress of civilization very largely depends on the increase of knowledge, may desire to aid in promoting that great result by the application of their means. See what immense benefits have arisen from the money grants that foreign governments have placed at the disposal of their scientific bodies; see what a stimulus there has been in the award of medals of honor, and, if you desire to witness the effect of a well-judged benefac-

tion, look at the Smithsonian Institution. I would not say one word in disparagement of gifts to colleges and universities, for it is indeed a noble purpose; but endowments for the promotion of a knowledge of nature conferred on scientific societies for the good of all men, no matter what their country or color, no matter what their religious profession or political condition, are still nobler. The one is a local and transitory benefaction, the other an enduring and universal benevolence.

In our own special science, chemistry, all that has been done has only served to extend the boundary of what remains. The thousands of analyses that have been made have brought us into a wilderness of results. We have not been able to rise to a point of view sufficiently high to discover what is the true place of those results in nature. We try to represent on the pages of our books and on our blackboards formulas of the constitution of things, conscious all the time that these are at the best only convenient fictions, which must necessarily change as we gain a more perfect insight into that grandest of all problems, the distribution of Force in Space, and the variations to which it is liable. The geometry of chemistry is that of three dimensions, not of two. We have to consider the relation of points not situated on one plane, and hence it is necessary to employ three axes of reference; nay, even more, we cannot avoid the conception of the mathematical method of quaternions. Our inadequate information respecting the real grouping of atoms is followed, as a necessary consequence, by imperfection in our methods of nomenclature—the confusion in this respect becoming, as we all too well know, every day worse and worse.

And now, while we have accomplished only a most imperfect examination of objects that we find on the earth, see how, on a sudden, through the vista that has been opened by the spectroscope, what a prospect

lies beyond us in the heavens! I often look at the bright yellow ray emitted from the chromosphere of the sun, by that unknown element, Helium, as the astronomers have ventured to call it. It seems trembling with excitement to tell its story, and how many unseen companions it has. And if this be the case with the sun, what shall we say of the magnificent hosts of the stars? May not every one of them have special elements of its own? Is not each a chemical laboratory in itself? Look at the clusters in the sword-handle of Perseus; in Cassiopeia, a universe of stars on a ground of star-dust; in Hercules, of which, as astronomers say, no one can look at for the first time through a great telescope without a shout of wonder—the most superb spectacle that the eye of man can witness! Look at the double stars, of which so many are now known, emitting their contrasting rays, garnet, or ruby, or emerald, or sapphire? Each is in accordance with its own special physical conditions, though all are under the same universal ordinance.

Now here a fact of surpassing importance presses itself on our attention. The movements taking place in those distant bodies are taking place under the same laws that prevail here on earth, and in our solar system. The law of gravitation, as developed by Newton, bears sway in all these distant worlds. In them bodies attract each other with forces directly as their masses and inversely as the squares of their distances. There the laws of the emission, absorption, and transmission of light are the same as they are with us. There ignited hydrogen gives forth its three rays, the same rays that it gives forth to us. In the uttermost parts of the universe the law of definite combination, the numerical law, and the multiple law, stand good. Sodium absorbs its two waves of definite refrangibility, and iron gives in the spectra its more than a hundred lines—more than a hundred silent but convincing witnesses of the uniformity of the constitu-

tion of the universe. There the number of vibration that constitute a ray of definite refrangibility is the same we have found it to be here. In the enormouss heat of those central suns, the dissociation of molecules may be of a higher order than we can reach artificially, but the law under which it takes place is a continuation of the law here. There, though the weight of a given mass of matter is different from what it is with us, it is nevertheless determined by the law that determines it here—the law of gravitation. There energy is indestructible, and is measured as it is measured among us, by work. Then is there any boundary that we can assign to natural law—is it not omnipresent, universal?

Perhaps there is no exaggeration in the assertion—for there seems abundant proof of its truth—that the light by which we see some of those distant orbs has crossed through such a prodigious space that millions of years have transpired during the journey. Then the phenomena it brings to us are those that were engendered in the beginning of the vast time so passed. Whatever there is that is in harmony with facts now happening here, is to us an unimpeachable evidence that the laws which were governing in those old ages have undergone no depreciation, but are active as ever until now. Then shall I exaggerate if I say that those laws are eternal in duration?

Infinite in influence, eternal in duration! what a magnificent spectacle! In the resistless energy of the motions of the universe, is there not Omnipotence? The Omnipotent, the Infinite, the Eternal—to what do these attributes belong?

Shall a man who stands forth to vindicate the majesty of such laws be blamable in your sight? Rather shall you not with him be overwhelmed with a conception so stupendous? And yet let us not forget that these eternal laws of nature are only the passing thoughts of God.

But grand as this is, there is something still grander. There is another temple into which we have to pass—not that of the visible, but that of the invisible. We must persist in the invasion we have made, in the revolution we have brought about in physiology. We have to determine the laws which preside in the nervous system of man, and discover the nature of the principle that animates it. Is there not something profoundly impressive in this, that the human mind can look from without upon itself, as one looks at his phantom image in a mirror and discern its own lineaments and admire its own movements. My own thoughts have of late years been forcibly drawn to this, from a recognition that the interpretation by the mind of impressions from without takes place under mathematical laws; as, for instance, that when external ethereal vibrations create in the mind a certain idea, that same idea will arise when the vibrations are doubled, or tripled, or quadrupled in frequency; but other ideas will be engendered by vibrations of an intermediate rate. Yet what these ideas will be may be predicted. It is true that this is only an optical case, but it extends the view that has been offered to us by a study of the structure of the ear. In the labyrinthine compartment of that organ the ultimate fibres of the auditory nerve are laid on the winding plane of the spiral lamina, in ever-decreasing lengths, each capable of trembling to the sound which is in unison with it—a mechanical action truly, answering to the sympathetic vibration with which the strings of a piano will respond to the corresponding notes of a flute—and these are translated by the mind into all the utterances of articulate speech, all the harmonies of music—speech that engenders new ideas within us; strains which, though they may die away in the air, live forever in the memory. The exquisite delight we experience in listening to the works of our great composers arises thus in mechanical movements, which are the issue of

mathematical combinations. The unseen world is under the influence of number!

But what is number except there be one who numbers? When Pompey, in his Syrian war, broke into the holy of holies at Jerusalem, he expressed, as Tacitus tells us, his astonishment that there was no image of a Divinity within—the shrine was silent and empty. And so, though after death we may anatomize and explore the inmost recesses of the brain, the vailed Genius that once presided there has eluded us, and has not left so much as a phantom trace, a shadow of himself.

The experiments of Galvani and Volta have not yet reached their conclusion; those of Faraday and Du Bois Raymond have only yielded a preliminary suggestion as to the nervous force. Excepting the great sympathetic nerve, the nervous fibres themselves are, as is well known, of two classes—those that gather the impressions of external things and convey them to the nerve centres, and those that transmit the dictates of the will from within outwardly. The capabilities of one of the former—the apparatus for sight—have been greatly improved by various optical contrivances, such as microscopes and telescopes, an earnest of what may hereafter be done as respects the four other special organs of sense; and as concerns the second class, the result of mental operations, the resolves of the will, may be transmitted with greater velocity than even in the living system itself, and that across vast terrestrial distances, or even beneath the sea. Telegraphic wires are, strictly speaking, continuations of the centrifugal nerves, and we are not without reason for believing that it is the same influence which is active in both cases.

In a scientific point of view, such improvements in the capabilities of the organs for receiving external impressions, such extensions in the distances to which the results of intellectual acts and the dictates of the

will may be conveyed, constitute a true development an evolution, none the less real though it may be of an artificial kind. If we reflect carefully on these things, bearing in mind what is now known of the course of development in the animal series, we shall not fail to remark what a singular interest gathers round these artificial developments—artificial they can scarcely be called, since they themselves have arisen interiorly. They are the result of intellectual acts Man has been developing himself. He, so far as the earth is concerned, is becoming omnipresent. The electrical nerves of society are spread in a plexus all over Europe and America; their commissural strands run under the Atlantic and the Pacific.

In many of the addresses that have been made during the past summer, on the Centennial occasion, the shortcomings of the United States in extending the boundaries of scientific knowledge, especially in the physical and chemical departments, have been set forth. "We must acknowledge with shame our inferiority to other people," says one. "We have done nothing," says another. Well, if all this be true, we ought, perhaps, to look to the condition of our colleges for an explanation. But we must not forget that many of these humiliating accusations are made by persons who are not of authority in the matter—who, because they are ignorant of what has been done, think that nothing has been done. They mistake what is merely a blank in their own information for a blank in reality. In their alacrity to depreciate the merit of their own country, a most unpatriotic alacrity, they would have us confess that for the last century we have been living on the reputation of Franklin and his thunder-rod.

Perhaps, then, we may without vanity recall some facts that may relieve us in a measure from the weight of this heavy accusation. We have sent out expeditions of exploration both to the Arctic and Antarctic

seas. We have submitted our own coast to a hydrographic and geodesic survey not excelled in exactness and extent by any similar works elsewhere. In the accomplishment of this we have been compelled to solve many physical problems of the greatest delicacy and highest importance, and we have done it successfully. The measuring rods with which the three great base lines of Maine, Long Island, and Georgia were determined, and their beautiful mechanical appliances, have exacted the publicly expressed admiration of some of the greatest European philosophers, and the conduct of that survey their unstinted applause. We have instituted geological surveys of many of our States and much of our Territories, and have been rewarded not merely by manifold local benefits, but also by the higher honor of extending very greatly the boundaries of that noble science. At an enormous annual cost we have maintained a meteorological signal system which I think is not equalled, and certainly is not surpassed, in the world. Should it be said that selfish interests have been mixed up with some of these undertakings, we may demand whether there was any selfishness in the survey of the Dead Sea? Was there any selfishness in the mission that a citizen of New York sent to equatorial Africa for the finding and relief of Livingstone? any in the astronomical expedition to South America? any in that to the valley of the Amazon? Was there any in the sending out of parties for the observation of the total eclipses of the sun? It was by American astronomers that the true character of his corona was first determined. Was there any in the seven expeditions that were dispatched for observing the transit of Venus? Was it not here that the bi-partition of Biela's comet was first detected; here that the eighth satellite of Saturn was discovered; here that the dusky ring of that planet, which had escaped the penetrating eye of Herschel and all the great European astronomers, was

first seen? Was it not by an American telescope that the companion of Sirius, the brightest star in the heavens, was revealed, and the mathematical prediction of the cause of his perturbations verified? Was it not by a Yale College professor that the showers of shooting stars were first scientifically discussed, on the occasion of the grand American display of that meteoric phenomenon in 1833? Did we not join in the investigations respecting terrestrial magnetism, instituted by European governments at the suggestion of Humboldt, and contribute our quota to the results obtained? Did not the Congress of the United States vote a money grant to carry into effect the invention of the electric telegraph? Does not the published flora of the United States show that something has been done in botany? Have not very important investigations been made here on the induction of magnetism in iron, the effect of magnetic currents on one another, the translation of quantity into intensity, and the converse? Was it not here that the radiations of incandescence were first investigated, the connection of increasing temperature with increasing refrangibility shown; the distribution of light, heat, and chemical activity in the solar spectrum ascertained, and some of the fundamental facts in spectrum analysis developed long before general attention was given to that subject in Europe? Here the first photograph of the moon was taken; here the first of the diffraction spectrum was produced; here the first portraits of the human face were made—an experiment that has given rise to an important industrial art?

Of chemistry, it may truly be affirmed that nowhere are its most advanced ideas, its new conceptions, better understood or more eagerly received. But how useless would it be for me to attempt a description in these few moments of what Prof. Silliman, in the work to which I have already referred, found that he could not include on more than

100 closely printed pages, though he proposed merely to give the names of American chemists and the titles of their works. It would be equally useless and indeed an invidious task to offer a selection; but this may be said, that among the more prominent memoirs there are many not inferior to the foremost that the chemical literature of Europe can present. How unsatisfactory, then, is this brief statement I have made of what might be justly claimed for American science! Had it been ten times as long, and far more forcibly offered, it would still have fallen short of completeness. I still should have been open to the accusation of not having done justice to the subject.

Have those who gloat over the shortcomings of American science ever examined the Coast Survey reports, those of the Naval Observatory, the Smithsonian contributions, those of the American Association for the Advancement of Science, the proceedings of the American Academy of Arts and Science, those of the American Philosophical Society, the Lyceum of Natural History, and our leading scientific periodicals? Have they ever looked at the numerous reports published by the authority of Congress on geographical, geological, engineering, and other subjects—reports often in imposing quartos magnificently illustrated.

Not without interest may we explore the origin of the depreciation of which we thus complain. In other countries it is commonly the case that each claims for itself all that it can, and often more than is its due Each labors to bring its conspicuous men and its public acts into the most favorable point of view; each goes upon the maxim that a man is usually valued at the value he puts upon himself. But how is it with us? Can an impartial person read without pain the characters which we so often attribute to our most illustrious citizens in political, and, what is worse, in social life? Can we complain if strangers accept us at our own depreciation, whether of men or things?

We need not go far to detect the origin of all this —it is in our political condition. Here wealth, power, preferment—preferment even to the highest position in the nation—are seemingly within the reach of all, and in the internecine struggle that takes place every man is occupied in pushing some other man into the background. I fear that in political life there is no remedy for this, such is the violence of the competition, so great are the prizes at stake. But in the less turbulent domain of science and letters we may hope for better things. And those who make it their practice to decry the contributions of their own country to the stock of knowledge may perhaps stand rebuked by the expressions that sometimes fall from her generous rivals. How can they read, without blushing at their own conduct, such declarations as that recently uttered by the great organ of English opinion, the foremost of English journals! *The Times*, which no one will accuse of partiality in this instance, says: "In the natural distribution of subjects, the history of enterprise, discovery, and conquest, and the growth of republics fell to America, and she has dealt nobly with them. In the wider and multifarious provinces of art and science she runs neck and neck with the mother country, and is never left behind?"

There are among us some persons who depreciate science merely through illiterate arrogance; there are some who, incited by superficiality, dislike it; there are some who regard it with an evil eye, because they think it is undermining the placid tranquillity they find in lifelong cherished opinions. There are some who hate it because they fear it, and many because they find that it is in conflict with their interests.

But let us, who are the servants of science, who have dedicated ourselves to her, take courage. Day by day the number of those who hold her in disfavor is diminishing. We can disregard their misrepresentations and maledictions. Mankind has made the great discovery

that she is the long-hoped-for civilizing agent of the world. Let us continue our labor unobtrusively, conscious of the integrity of our motives, conscious of the portentous change which is taking place in the thought of the world, conscious of the irresistible power which is behind us! Let us not return railing for railing, but above all, let us deliver unflinchingly to others the truths that Nature has delivered to us!

The book of Nature! shall not we chemists, and all our brother-students, whether they be naturalists, astronomers, mathematicians, geologists, shall we not all humbly and earnestly read it? Nature, the mother of us all, has inscribed her unfading, her eternal record on the canopy of the skies, she has put it all around us on the platform of the earth! No man can tamper with it, no man can interpolate or falsify it for his own ends. She does not command us what to do, nor order us what to think. She only invites us to look around. For those who reject her she has in reserve no revenges, no social ostracism, no index expurgatorius, no auto da fé! To those who in purity of spirit worship in her heaven-pavilioned temple, she offers her guidance to that cloudy shrine in which Truth sits enthroned, "dark with the excess of light?" Thither are repairing, not driven by tyranny, but of their own accord, increasing crowds from all countries of the earth, conscious that whatever their dissensions of opinion may heretofore have been, in her presence they will find intellectual concord and unity.

XXX.—Manufacture of Artificial Butter.

BY H. A. MOTT, JR., PH.D.

(Read Nov. 2, 1876.)

Condensed report by the Committee on Papers and Publications.

History. — The first patent on this subject was really taken out by Mége in England, July 17, 1869, but as it was not issued in this country until 1873, we

will refer to it later on. The patents in chronological order are:

H. W. Bradley, Jan. 3, 1871, for a new composition for lard or butter for culinary uses and other purposes.

H. W. Bradley, Oct. 17, 1871. Deodorizing cotton-seed oil to render it suitable for culinary use.

Peyrouse, Nov. 2, 1871. Application of fine fats, as beef fat, to culinary purposes, a product being obtained between butter and lard.

Alfred Paraf, April, 1873. "Artificial butter," called oleomargarine. The objections to the product were that it possessed a grain, and in a short time lost the color and flavor of butter. The process pursued was closely akin to the true process.

Joseph Brown, Dec. 23, 1873. Purifying tallow.

Mége. Patented in England July 17, 1869. In United States December 30, 1873. Reissued May 12, 1874. This covers the principal points in the manufacture of artificial butter. 1st. The extraction of the oil from the fat at a low temperature, not over 125° F., and 2d, the conversion of the oil by churning with milk into butter. These patents are now the property of the United States Dairy Company. Some few modifications have been found necessary to remove the "grain" from the butter, and to cause it to retain the odor and flavor so much prized in the best qualities of butter.

Several other patents may be mentioned in this connection, though they all infringe the specification of Mége's patent, requiring that the oil shall be extracted from the fat at a low temperature (under 125° F.). Such are:

Francis Kraft, July 21, 1874. Separating stearine from olein.

William E. Andrew, Aug. 11, 1874. Separating oleomargarine and stearine from animal fats.

John Hobbs, Aug. 18, 1874. Improvement in

treating animal fats. The product obtained is a mixture of tallow and butter.

William L. Churchill and J. L. Englehart, Aug. 25, 1874. Improvement in treating animal fats and manufacturing artificial butter.

The process, with the exception of the use of a peculiarly shaped receptacle for the fat, is nearly the same as that of Paraf.

G. B. Van Brunt, Oct. 13, 1874. Improvement in processes of manufacturing products from animal fats. The product obtained he calls oleo-palmitin.

William E. Andrew, Aug. 24, 1875. The process set forth in this patent for removing the grain and introducing the flavor of butter, etc., is the process discovered by myself. I had used this process successfully for a year before he obtained his patent, and had succeeded in removing the grain some three years before.

J. P. Kinney, Oct. 19, 1875. Improvement in processes in purifying and preserving animal fats. The product is simply purified fat.

William E. Andrew, Nov. 16, 1875. Reissue of his patent of August above alluded to. The temperature at which the oil should be separated is here specified as about 140° F.

G. Cosine, Feb. 15, 1876. Improvement in processes for making artificial butter. Two products are to be manufactured by this process, the one for summer, the other for winter use. The former is obtained by a process similar to that of Paraf; the latter consists of a mixture of olein with fruit or nut oil, salted.

True Process of Manufacturing Artificial Butter.—The first requisite is exquisite cleanliness. The fat is first sorted; all portions to which blood adheres being washed separately. It is washed first with tepid water, and then three times with cold water.

The fat is then passed through the "hasher," by which it is cut very fine, and finally forced through a

fine sieve. The product is then placed in the "melting tank," in which it is heated by heating the water surrounding it, until the temperature of 122° or 124° F. is attained. Experiments have shown that this temperature cannot be passed and a sweet and odorless oil obtained.

In this process the fat must be continually stirred to maintain an even temperature. When the fat has melted it is allowed to stand that the "scrap" may settle to the bottom. The fat is then skimmed, and the clear oil is drawn off and set aside to cool in wooden cars. Should the scrap refuse to settle, vigorous stirring will usually cause it to do so. If not, throwing on some salt and stirring it will have the desired effect. This melting process occupies some two to three hours. The oil in the cars requires at least twelve to twenty-four hours to granulate, which should take place at a temperature of about 70° F.

The solidified oil is now taken to the "press-room," which is kept at a temperature of about 89° to 90° F. Here it is packed in cloths and is then put under the press. The pressure should only be gradually increased, and is continued until the oil ceases to flow. The oil is caught in a suitable receptacle, while the cakes which remain consist of pure white stearine, which is ready for sale.

The oil is again cooled to 70° F. One hundred pounds of the oil are then taken, and with fifteen to twenty pounds of sour milk, are placed in the churn. Two and a half to three ounces of solution of annatto, containing one-half to three-fourths ounce of bicarbonate of soda, may then be added, and the whole is agitated for about ten or fifteen minutes, when it is at once run into a tub containing pounded ice, the oil being kept in constant motion until sufficiently cooled. By this process the grain is completely removed. After remaining in contact with the ice for two or three hours, it is then dumped on an inclined table

and crumbled up so that the ice may melt out. Then about thirty pounds at a time are put into a churn with

	Poor Artificial Butter. (Mott.)	Artificial Butter. (Dr. Brown.)	Good Artificial Butter. (Mott.)	Good Artificial Butter. (Mott.)	Average of two preceding.	Butter from Cream.
Palmitin $C_{51}H_{98}O_6$					18.307	16.897
Stearin $C_{57}H_{110}O_6$					36 502	35.999
Olein $C_{57}H_{104}O_6$					24.954	22.934
* Butyrin $C_{15}H_{26}O_6$	75.39	87.15	82.41	51.64		
Caproin $C_{21}H_{38}O_6$						
Caprin $C_{33}H_{62}O_6$					0.363	7.505
Caprylin $C_{27}H_{50}O_6$						
Casein	0.91	0.57	0.63	0.86	0.745	0.168
Salt (NaCl)	4.09	1.03	4.83	5.63	5.295	5.295
Coloring matter	trace.	trace.	trace.	trace.	trace.	
Butter solids	80.39	88.75	87.87	88.13	87.995	88.173
Water	19.65	11.25	12.13	11.86	12.005	11.827
	100.00	100.00	100.00	100.00	100.000	100.000

* The butyric acid was ascertained by analysis, which is approximately correct. All volatile fats are calculated as butyrin.

twenty to twenty-five pounds of churned sour milk, and the whole is churned for about fifteen minutes.

By this last process the flavor and odor desired is imparted to the butter.

Working, draining, and salting the product (three-quarters to one ounce of salt to the pound) completes the manufacture.

The foregoing table shows the comparative composition of artificial butter and that made from cream in the ordinary way. The percentages in the artificial and natural butter are calculated to a uniform percentage of salt in order to show the correspondence more perfectly. An analysis of artificial butter by Dr. Brown is also appended.

Cost of Manufacture, etc.—In order to set up an establishment to produce 500 pounds of butter daily, a floor some 50 × 75 feet, supplied with steam power and plenty of running water, would be required. The fittings would cost about $2,500, but it would require a capital of at least $6,250 to carry on the business. The following would be about the amount of butter and by-products obtained from 691.65 pounds of caul fat:

Butter	500	pounds.
Stearine	128.85	"
Soap grease	29.81	"
Scrap	117.41	"

The last is an unsalable product. The cost of manufacturing the butter would be about thirteen cents per pound.

In warm climates the butter could not be profitably made in July and August; therefore the oil should be manufactured in these months and stored against cool weather.

XXXI.—Contributions to Volumetric Analysis. First Paper—On a New Portable Burette.

BY P. CASAMAJOR.

(Read November 2, 1876.)

The necessity of estimating potassa and soda in their commercial carbonates with accuracy and rapidity, gave rise to volumetric analysis, and I believe

that Descroizilles was the first chemist who substituted the measuring of a certain volume of acid of known strength for the slower and more delicate operation of weighing.

To ascertain the exact volume of sulphuric acid required to saturate a known weight of alkali, Descroizilles used a graduated tube, about twenty-five centimetres high, with a diameter of fifteen millimetres. This was provided with a very narrow neck, whose upper portion was expanded and provided with a lip. On the shoulder, near the base of the narrow neck, was a small opening, which, by being closed more or less perfectly by the application of a finger, allowed the titrated acid to run out with more or less rapidity. The word *burette*, applied to this instrument, was very appropriate, as in French *burette*, as defined by Boiste,* is a small flask with a narrow neck, and is a diminutive of *buire*, which means a large flask. This word was adopted afterwards by Gay Lussac to designate his graduated drop tube, and it has been applied to all instruments designed to fulfil the same purpose, whatever be the variety of their shapes.

In the burette of Gay Lussac, which was the immediate successor of the instrument of Descroizilles, the liquid is poured out through a very narrow tube, which may have been suggested by the narrow neck of the primitive flask. This burette has the advantage over some other forms now adopted, that it is made entirely of glass, and is therefore able to hold any of the test liquors used in volumetric analysis, and also that its contents can only run out when the instrument is in the hands of the operator. I believe that it is generally preferred to other forms, and that more of them are sold than of any other kind. Two other

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* The definitions of Boiste are as follows:

Buire, *s. f.* flacon—grand vase.

Burette, *s. f. Urceolus*, petite buire—vase à petit goulot pour l'huile pour l'eau et le vin à la messe.

burettes are in general use, in both of which the liquid drops directly from the bottom of the graduated tube, its flow being regulated either by a glass cock or by a pinch-cock acting on a flexible rubber tube. This latter instrument is the invention of Dr. Federick Mohr, and we may say of it that, for solutions which have no action on india-rubber, no better burette could be desired.

In the investigations which I lately made on the estimation of potassium as acid tartrate, which I had the honor of laying before you at our September meeting, I had repeatedly occasion to use a titrated solution of potassic hydrate, which could not be held in Mohr's burette, on account of the rubber tube. A burette with a glass cock, which I used at first, was finally laid aside, as the normal alkaline solution was continually leaking out, around the key of the cock. This key itself fitted very perfectly, but it had to be slightly loosened from its seat to allow it to be turned with nicety, and the play left in this manner was sufficient to let a portion of the contents leak out; and as the whole of this did not find its way to the beaker glass, but some remained on the outside of the burette, errors were committed which materially affected my results. A burette of Gay Lussac gave much more satisfactory and concordant results, as no leakage took place under any circumstances. This burette, however, is inconvenient to use, because a constant watch must be kept on its liquid contents if the outflow is to be regulated with precision, and this is not an easy matter, as the attention of the operator is divided in observing both the outflow and the effect of the test liquor on the solution in the beaker glass. This defect is aggravated by the circumstance that, towards the end of the operation, when the effect of every drop of test liquor on the solution under examination has to be watched with the closest attention, the management of the burette becomes the most difficult,

on account of its greater deviation from a vertical position. Having suffered a great deal of inconvenience from this defect, I endeavored to overcome it by several devices, and was finally led to adopt an entirely new form of burette, which I find more convenient than any other with which I am acquainted, and which it is my busines to describe to you this evening.

The burette, represented in Fig. 1 and Fig. 2, is a

Fig. 1

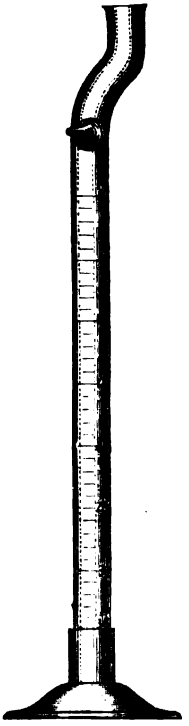
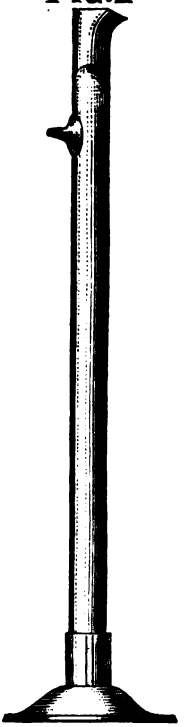


Fig. 2



cylindrical tube, closed at the bottom. For the sake of convenience and safety, this tube is inserted in

a stand or foot, in the manner proposed by Dr. Mohr for Gay Lussac's burette. This foot is made of japanned tin, which is better in every way, and more economical than wood. The cylindrical portion of this tin stand is only partially soldered on the flat part, to allow the portion left free to act as a spring in holding the glass cylinder tightly. The upper portion of the glass tube has the shape shown in Fig. 1, to prevent the liquor from running out when the tube is inclined. The same object is usually accomplished by bending the upper portion at an obtuse angle on the main stem; but I have preferred the shape shown in Fig. 1, as the burette is more easily filled while standing vertically on its foot.

Immediately under the curved portion of the burette, is a break, from which the liquor drops when the instrument is inclined and properly turned. By making a transverse section through this beak, we obtain Fig. 3 and Fig. 4, which show the shape of the

Fig. 3

Fig. 4

beak, and its position in relation to the stem for two positions of the tube.

To allow the liquor to drop from the burette, it is inclined as in Fig. 5, in which position the curved portion at the upper end prevents the liquid from pouring out. Keeping the tube inclined, as in this figure, we may either prevent the outflow of its contents, or allow it to run with more or less rapidity.

To effect this, it is merely necessary to turn the in-

strument around its own axis, so that the beak may be either raised or lowered, as shown in Fig. 3 and Fig. 4. When the beak is allowed to take the position shown in Fig. 3, the liquid in the tube does not run out; while in the position shown in Fig. 4, the drops run out quite rapidly. At some intermediate point it will be found that the liquid runs out slowly in drops, which may be accelerated or retarded by turning the tube around its axis, but without changing the inclination of this axis.

Fig. 5

The motion imparted to the burette by holding it in the hand, and simply turning it around its axis, is an easy one for the operator, who is not obliged to watch the liquid in the instrument with any degree of attention. As the liquid runs out of the burette, it becomes necessary to incline its axis more and more, to keep a supply of liquid near the beak; but there is no difficulty connected with this, as the liquid runs out with equal ease when the instrument is full to the O mark as when it is nearly empty. When the changes which occur in the liquid under examination indicate that the operation is nearly ended, the liquor may very easily be made to fall in single drops by turning the beak down gradually, and raising it again with a sudden motion. This is easily learnt by a little practice, and does not require a close watch on the contents of the burette.

The most convenient position for the operator is to hold the tube almost horizontally and to let the foot roll on a block of proper height, while the necessary

motions are given to the instrument by holding it with one hand near its open end. This presents the additional advantage that the portion which becomes heated by the hand is not in contact with the liquid contents of the tube.

This position, however convenient, is not necessary, as it does not happen with this burette, as with Gay Lussac's, that almost every time the instrument is partially raised, a little drop of test liquor settles at the end of the small tube, and prevents further outflow, which is a source of endless annoyance and delay.* As the beak always remains full of liquid, this new burette is ready to give a drop whenever the tube is properly inclined and turned.

Whenever it becomes necessary to lift the instrument, the beak should be previously raised by turning the tube, as otherwise a drop of liquid may escape and run down the side of the tube. After the operation is ended, the burette should be left in a vertical position for some minutes, to allow the liquid to run down before reading the indication of the scale. As the beak holds by capillarity a certain quantity of test liquor, it will be found convenient to keep it full whenever the indications of the scale are observed. This beak usually becomes filled of itself at the time of filling the instrument with test liquor. The open

* This occurs principally with alkaline solutions. If the small tube of Gay Lussac's burette is carefully watched, it will be seen that when an alkaline solution runs down this tube, the main portion of the liquid fills up the tube; but it is preceded by a low wave, which keeps ahead of the main portion, however fast or slow the liquid runs down. This wave arrives at the nozzle before the other portion and fills it, leaving a volume of air between the two portions. With acid solutions, the wave does not exist, and the tube is seldom stopped.

The plan usually adopted to renew the flow, when it has been stopped by a drop of liquid at the nozzle, is to blow into the main tube. This is very objectionable, as by blowing we may obtain a small stream but not a drop. Towards the end of an operation this might spoil a test. The possibility of obtaining a drop at any time with ease and certainty is the great desideratum in a burette.

end of the burette may be provided with a lip, on the side opposite to the beak, as shown in Fig. 2. This is to allow the test liquor to run out faster when desired.

Many chemists are unwilling to trust volumetric analysis for fear of the changes of volume which are due to changes of temperature. They are, however, willing to use the solutions of this method of analysis, and they have adopted a gravimetric system, which consists in weighing instead of measuring their test liquors. For this manner of using test solutions, I have made the gravimetric burette represented in Fig. 6. The manner of using this burette is precisely the same as for the volumetric instrument, and it does not require any further explanation.

Fig. 6

The weight of test solution used in an analysis is best determined by double-weighing. The flask or gravimetric burette, containing a greater quantity of test solution than will be required by the analysis, is placed on the scales and counterbalanced with shot or any other material. After the operation is ended, the flask should be replaced on the same pan of the scales, and be made to counterbalance the original quantity of shot by adding weights, which represent the weight of test solution that has been used. A common balance weighing 200 grammes and turning to 1 centigramme is sufficient for this method of testing.

In making and graduating these instruments, I have had the valuable services of Mr. Henry Weinhagen, No. 152 William Street, New York. Although any other person may manufacture them, I can say that Mr. Weinhagen has given entire satisfaction.

XXXII.—On the Determination of Phosphorus in Pig-Iron by means of Molybdic Acid.

BY F. A. CAIRNS, A.M.

(Read Nov. 2, 1876.)

The comparatively large demand for iron containing a small percentage of phosphorus has led to a close examination of the different methods of determining this substance, commonly, if not invariably, occurring in iron ores, and consequently in the metallic product. Among the various methods suggested and most highly approved is Sonnenschein's, commonly known as the "molybdic acid method." The writer, after having employed it for years in hundreds of analyses, with apparently good results, has within the past two years heard it charged with giving results too low. Although satisfied of the accuracy of the method by previous experiments, he concluded to make further ones, as far as time and opportunity allowed, to settle any doubt in his own mind at least. The first step taken was to determine the amount of phosphorus remaining in solution in residues. To this end the filtrates from ten analyses, representing fifty grammes pig-iron, and containing a large excess of molybdic acid, were left for several months in a closet, the temperature of which was for a considerable portion of the time above 100° F., and after filtering out a small precipitate, heated until even some iron oxide and molybdic acid were precipitated, which precipitates were carefully analyzed.

The phosphorus recovered amounted to 0.002 per cent ($\frac{2}{1000}$). The same plan was afterward adopted with the residual fluids from fourteen analyses, representing seventy grammes of pig-iron. In this case the phosphorus recovered amounted to 0.0027 per cent. ($\frac{27}{10000}$).

In the meantime several samples of iron borings were sent to a laboratory, where numbers of determinations of phosphorus are made for manufacturers of

steel, by a method claimed by many to be superior to Sonnenschein's. It is to be regretted that (owing to pressure of business and accidents) only one return was made, which gave 0.1560 per cent. phosphorus in a sample which we reported as containing 0.1564 per cent

The results are practically identical, and seem to show that the loss of phosphorus, due to solubility, is the same in both methods.

The next step was to attempt the recovery of phosphorus in iron solutions containing a known amount. For this purpose a solution of hydro-disodic phosphate was prepared, containing one gramme in one litre of water, which, upon repeated analyses, was found to contain 0.08755 gramme phosphorus.

Theoretically the result should have been 0.08659 gramme. The difference, 0.00096 gramme, or about one milligramme in one litre, is probably due to slight efflorescence of the crystals used.

Of this solution 100 c.c., containing 0.008755 gramme of phosphorus, was used in each of the final analyses. Then solutions, each containing five grammes of fine iron wire (carefully cleaned), were prepared by the method employed in the analysis of pig-iron, described below. Some of these solutions were analyzed for phosphorus, and the amount found to be 0.001871 gramme. Finally, two of the five-gramme solutions of iron wire were each combined with 100 c.c. of the solution of hydro-disodic phosphate, and analyzed as in the case of the iron wire alone.

The first analysis gave 0.010445 gramme phosphorus, and the second gave 0.010472 gramme, or, to state it in tabular form:

First Analysis.

Five grammes wire contain	0.001871 grm. P.
100 c. c. $Na_2H.PO_4$, $12H_2O$ solution contain	0.008755 grm. P.
Total phosphorus taken	0.010626 grm. P. = 0.2125 per cent.
Phosphorus found in above	0.010445 grm. P. = 0.2089 "
Loss of phosphorus	0.000181 grm. P. = 0.0036 "

Second Analysis.

Five grammes wire contain.....0.001871 grm. P.
100 c. c. $Na_2H.PO_4$, $12H_2O$ solution
contain.....0.008755 grm. P.

Total phosphorus taken....0.010626 grm. P. = 0.2125 per cent.
Phosphorus found in above.....0.010472 grm. P. = 0.2094 "

Loss of phosphorus.....0.000154 grm. P. = 0.0031 "

The loss of phosphorus is not greater than the error allowed for difference in the weights of filter ash, and might be so considered did it not agree so nearly with the amount of phosphorus shown by the first experiments to be retained in solution.

The difference of 0.0005 ($\frac{5}{10000}$ of one per cent.) between the two analyses is of course far less than allowed error, being explainable by a difference of 0.0002 gramme in ash of filters.

It is well to state that the filters used in the different analyses were of the same size, and the solutions so nearly alike in volume as to render corrections for solubility unnecessary.

The method employed by the writer in the analysis of pig-iron, and pursued in these experiments, is as follows:

To ten grammes potassium chlorate, dissolved in 200 c.c. water, and heated to boiling in a capacious flask, are added five grammes iron borings or chips, and then 60 c.c. concentrated hydrochloric acid (*little at a time*). The fluid is kept boiling gently until all the iron is dissolved. The solution is then transferred to a dish, evaporated to dryness, and kept at a temperature of about 110° C. until free hydrochloric acid is expelled. The dry mass is then treated with hydrochloric acid and water, and heated until the iron oxide is dissolved; the solution is then filtered from the silica.

The iron oxide carrying the phosphoric acid is precipitated from the solution by ammonia, filtered out and washed moderately (the water required to remove

the precipitate to the filter being sufficient). The walls of the glass in which the precipitation is effected are washed down by about 25 c.c. concentrated nitric acid. To this the precipitate is transferred by means of a spatula, with occasional stirring. After removing all the precipitate that can be conveniently reached by the spatula, the solution is poured through the filter and the filter well washed with water, into a beaker of medium size. By this means complete solution is effected in a very short time. This solution is now boiled down to a very small bulk to remove all chlorine and excess of nitric acid, diluted to a volume of about 250 c.c., and neutralized by ammonia until the color is that of light mahogany. To this an excess of "molybdic acid solution" is added, and the whole kept at a temperature just below boiling for an hour or two. As soon as the precipitate settles, it is filtered out and washed with diluted "molybdic acid solution" and the filtrate again partially neutralized, warmed and allowed to stand for five or six hours in a warm place. Any precipitate is then filtered out and washed as above, and the filtrate tested again.

In rare cases a third small precipitation occurs, which can, however, be carried through the regular stages of the analysis so as to cause no delay.

The washed precipitates of phospho-molybdate are dissolved through the filters by ammonia into a small beaker, and the filters washed with water. As a small quantity of iron oxide, enough to color the filter around the edges, if not more, almost invariably remains after washing, nitric acid is now poured through the filter, in small quantity, into the beaker containing the ammoniacal solution (to which enough "molybdic acid solution" has been added to precipitate any phosphoric acid that may be combined with the iron oxide), and enough more nitric acid added to render the solution acid (avoiding large excess).

By this means the phospho-molybdate is precipitated free from iron, which may have been previously co-precipitated. The acid solution is allowed to stand for a few hours in a warm place until the supernatant fluid is clear. It is well, although rarely necessary, to test this fluid, after filtering, by gently warming and allowing it to stand for a time. The precipitate is filtered out and washed with "molybdic acid solution" and dissolved by ammonia. To the solution is added enough hydrochloric acid to render it acid, and then enough ammonia to make it decidedly alkaline, and finally "magnesia mixture."

The whole is now set aside in the cold until the precipitate of ammonio-magnesian phosphate is entirely formed, when it is filtered, washed with dilute ammonia, dried, ignited, and weighed. The determination can be made in five days, or perhaps sooner, if necessary. The safer plan is to allow that time. The results seem to bear out the assertion, that at present we are acquainted with no method more accurate.

It is claimed by many chemists that a method, turning on the reduction of iron oxide by means of sulphites, particularly that of ammonium, and precipitating the iron phosphate in connection with a small amount of oxide by means of sodium acetate, etc., gives better results. Experiment certainly does not bear out the assertion. The difficulties encountered in connection with the use of molybdic acid are probably due to inexperience.

It has fallen to the lot of the writer to use this reagent in hundreds of analyses, and he may be pardoned for stating, in addition to the experiments above described, that upon reviewing a number of determinations of phosphorus in pig-iron made by him this year, the average discrepancy between duplicates is 0.0023 per cent. ($\frac{2.3}{100}$), amounting in only two cases to 0.005 per cent., while in a number of instances the results were identical.

As to the temperature at which the precipitation of phospho-molybdate takes place most rapidly, in the presence of iron oxide, it was suggested to try some experiments. For this purpose five grammes of iron-borings, the composition of which had been previously determined, were, after the addition of "molybdic acid solution," in considerable excess over the quantity *known* to be required, allowed to stand for twenty-four hours at a temperature prescribed by Fresenius, (40° C.). The precipitate, filtered and treated as usual, contained phosphorus equivalent to 0.0279 per cent. The filtrate, to which a considerable quantity of molybdic acid had been added by washing the first precipitate, was allowed to stand twenty-four hours longer at the same temperature as in the first instance, when another much heavier precipitation occurred, which gave 0.1256 per cent. of phosphorus. The same plan was pursued again when 0.0056 per cent. phosphorus was recovered after the next twenty-four hours. The filtrate from the last precipitate was then heated to a point just below boiling for two or three hours and allowed to stand for twenty-four hours as before, when another precipitate formed, equivalent to 0.0112 per cent. phosphorus.

The phosphorus, recovered in four precipitations requiring four days, amounted to 0.170 per cent. in a sample of iron, in which the phosphorus had been precipitated as phospho-molybdate in one and a half days at the higher temperature, and found to amount to 0.172 per cent.

It is proper to state that the precipitates formed at the lower temperature contained quite as much iron oxide as is usually found in those occurring at a higher temperature. In solutions not containing much alumina or iron oxide, there may be no advantage in precipitating at a high temperature, but in other cases the reverse seems to be the case.

School of Mines of Columbia College, Nov., 1876.

XXXIII.—Alcohol in Statu Nascendi.

BY H. ENDEMANN, PH.D.

(Read Nov. 2, 1876.)

It is a well-known fact that substances, ready formed, frequently do not unite, while, if they are in statu nascendi, they may readily do so, and it would therefore be useless to give the facts, which I intended to produce in the following note, if they did not have an important bearing on the practical application of a substance, which has of late been brought to the knowledge of the general public as an excellent preservative—*salicylic acid.*

During the early part of this year I had occasion to introduce a new process for the manufacture of vinegar.

To circumvent the oppressive tax on alcohol and whiskey, which are used for the manufacture of colorless vinegar, a mash is made, fermented and converted to vinegar in the ordinary way. The sour mash is then distilled in order to obtain a colorless article free from foreign substances.

Practically, of course, the fermentation is never a complete one, on account of the protective power of the alcohol for the sugar, which can only be entirely fermented by very long treatment, which, in a manufactory where thousands of gallons had to be fermented daily, was found impracticable.

The consequence was, that the sour mash would, after some days' standing, ferment anew; but the result of this fermentation was not alcohol, but acetic ether.

Diluted alcohol and acetic acid mixed can remain un-united for a considerable time; but if the alcohol is in statu nascendi, the combination of alcohol and acetic acid is produced at once.

This fact, which was known to me, enabled me easily to understand a peculiar process which had been

going on in a wine, which had been treated by authority of Neubauer with salicylic acid.

Neubauer had stated that wine may be preserved by the addition of from 20 to 60 mgs. of salicylic acid to the litre. This would represent about one part in 50,000 parts, or one part in 16,000 parts.

A manufacturer of wine in the southern part of New Jersey, where extensive vineyards are to be found, had sold a keg of wine containing twelve gallons. The wine was young and apt to ferment again, and, as it went into hands which he considered not over careful, he had considered it necessary, for the purpose of preventing a change in the wine, while in the hands of its consumer, to add a small quantity of salicylic acid, about one gr. to the twelve gallons, or one part to about 48,000 parts, which is a little more than the minimum quantity as given by Neubauer. The wine remained, however, on his hands, and he had occasion to fully study the influence of the acid on his wine. He first claims that the wine lost its natural flavor entirely, and that by degrees this was substituted by a new flavor, which he thought was like camphor. When I received the wine first, I pronounced its flavor at once to have its origin in the presence of salicylic ether, and in fact this could easily be demonstrated by flavoring some natural wine with the oil of wintergreen. Oil of wintergreen is the methyl ether of salicylic acid; but it is so similar to the ethyl ether, regarding its flavor, that a German firm on the Philadelphia Exhibition had exhibited a glass of salicylic ethyl ether as artificial oil of wintergreen.

The formation of this ether may be understood if we regard the circumstances. The wine was only one year old, and therefore could not be considered ripe and ready for sale, and should therefore have received, not the minimum quantity, but rather more salicylic acid to entirely prevent after-fermentation. The quantity therefore being insufficient, salicylic acid

came in contact with alcohol in statu nascendi, which caused this abnormal action.

Wine-growers are naturally very suspicious of chemicals, and are therefore very apt to make the same mistake; that is, they prefer to use a minimum quantity, and I should not be surprised if similar experiences had followed the application of this substance in other places.

It is according to Prof. Neubauer's prescription that a minimum quantity of salicylic acid be used; but this minimum quantity, being different for each brand, is to be determined preliminarily by experiments on a small scale.

XXXIV.—Proceedings.

Regular Meeting, Dec. 7th, 1876.

The meeting was called to order at 8.15 P.M., Vice-President Chandler in the chair. The minutes of the last meeting were read and adopted. The Chairman, on behalf of the Council of the Society, presented the following resolutions:

1st. "That the ballots for regular officers of the Society for the year 1877 be sent to all members and counted at the *conversazione* to be held on Dec. 21st, in order to allow non-resident members to cast their votes." Carried.

"That the Committee on Permanent Rooms be discharged, and that the chair appoint a new committee instead." Adopted.

The following gentlemen were then appointed by the chairman as Committee on Permanent Rooms: Messrs. Goldschmidt, Waller, Ledoux, and Mott.

The Society proceeded to the election of new members. The following were declared elected: Andrew P. Aitkin, Edinburg, Scotland; Wm. Ashburner, San Francisco, Cal.; P. T. Austen, Stapleton, N. Y.; J. C. Booth, Philadelphia, Penn.; David H. Cochran, Brooklyn, N. Y.; Wolcott Gibbs, Cambridge, Mass.;

C. L. Jackson, Cambridge, Mass.; O. A. Moses, Charleston, S. C.; E. H. Lecour, N. Y.; W. Wheatley, N. Y.

The following were proposed:

As members—W. N. Hill, Newport, R. I.; E. N. Horsford, Cambridge, Mass.

As associates—Fred. H. Elder, N. Y.; C. B. F. Lowe, Augusta, Ga.; Jas. L. Morgan, N. Y.; Stewart C. Squier, Rahway, N. J.

The Secretary stated that he had received applications for membership from some strangers, and would like to hear the sentiment of the Society in regard to such applications. He was instructed to inform the applicants that the rules of the Society required that proposals for admission must be signed by three members of the Society, and to request said applicants to conform to this rule.

The first paper of the evening was read: "Analyses of Mine Waters from the Lead Regions of South-west Missouri," by C. P. Williams. In the discussion which followed, Dr. Chandler said he saw no solvent for the antimony. Dr. Alsberg thought it might be held in solution by the organic matter present. Prof. Chandler also gave Whitney's views about the formation of the Missouri lead deposits.

The second and third papers were read by P. Casamajor: "On a New Mounted Burette," and "On Correction of the Errors Due to the Variations of Temperature."

The fourth paper read was that "On Potable Water," by H. B. Cornwall.

The chair announced the death in San Francisco of Mr. T. M. Blossom, a member.

A letter, received from Prof. Collier in Burlington, Vt., asking for information about charges for an examination for poisons, was referred to the Council.

Prof. T. Egleston sent a communication in regard to the Inaugural Address, which was received and placed on file.

Dr. Martius, of Berlin, informed the Society by letter that the "Deutsche Chemische Gesellschaft" will exchange their proceedings with ours, and that an official communication to that effect will soon be made.

Prof. T. Sterry Hunt caused to be submitted to the Society a plan for an international geological exhibition and congress, to be held in Paris in 1878.

Mr. W. A. Miles invited the Society to hold its next *conversazione* at his brewery. It was resolved to accept the invitation. Adjourned.

M. ALSBERG, Rec. Sec. *pro tem.*

XXXV.—PROCEEDINGS.

Regular Meeting, January 4th, 1877.

The meeting was called to order at 8.30 P.M., Vice-President Chandler in the chair. The minutes of the last meeting were read and adopted. The different committees, through their respective chairmen, made their annual reports, which were adopted. The report of the Treasurer showed a balance in bank of $1,363.04. The Treasurer recommended that only one signature to all checks and vouchers be declared necessary, instead of two as hitherto, and that he be authorized to retain small amounts in his own keeping until in possession of a sum large enough to deposit in the Chemical Bank. Referred to the Council.

The result of the annual election of officers for 1877, held December 27th, 1876, was announced, the ticket as fixed upon in Committee of the Whole having been elected. In consequence of the absence of the Recording Secretary *pro tem.*, Dr. Walz, Mr. Alsberg was elected Recording Secretary *pro tem.*

The Committee on Permanent Rooms reported that they could make no definite arrangements until instructed with regard to the sum which the Society would be willing to expend; that some members had offered an annual contribution of $100 for one or two years for the establishment of permanent rooms, and that

they be authorized to receive such subscriptions. After some discussion it was decided to grant such authority, with the understanding solicitations should be confined to members, and the engagement of permanent rooms should be postponed until such time as the financial condition of the Society should be stronger than it is at present.

The Society then proceeded to the election of members. The following were declared elected:

Members.—W. N. Hill, Newport, R. I.; E. N. Horsford, Cambridge, Mass.

Associates.—C. B. F. Lowe, Augusta, Ga.; James L. Morgan, N. Y.; Stewart C. Squier, Rahway, N. J.; Fred. H. Elder, N. Y.

The following were proposed as members: A. J. Corning, Baltimore; J. D. Hague, San Francisco; A. Means, Oxford, Ga; John Thellberg, Jersey City. The resignations of F. W. Clarke and P. Frazer were accepted. Dr. C. A. Doremus laid before the Society a personal matter concerning professional etiquette, which was ruled out of order.

Adjourned.

M. ALSBERG, Rec. Sec. *pro tem.*

XXXVI.—THE AMERICAN CHEMICAL SOCIETY,

IN ACCOUNT WITH W. M. HABIRSHAW, TREASURER.

1876.

Dec. 30.	To rent as follows:			
	Emil Heim, May 26.....	$25	00	
	Chickering Hall, Nov. 16,	75	00	$100 00
Dec. 30.	To Stationery, Printing, etc.:			
	T. J. Marcellus, May 6....	8	75	
	T. J. Marcellus, June 1....	11	25	
	Chas. Vogt, June 1.....	80	75	
	I. Walz, June 12.....	33	99	
	Chas. Vogt, Sept. 29.....	16	65	
	I. Walz, Oct. 2.....	10	92	
	Kinmel, Oct. 31.....	29	00	181 31

Dec. 30.	To advertising Inaugural Address.....			29 88
"	To printing proceedings.....			42 55
"	To printing list of members..			39 50
"	To postage:			
	Hussey Message Post.....	14 07		
	Postage stamps.....	9 65		23 72
"	To balance.....			1,363 04
				$1,780 00

Dec. 30.	By cash received to date as follows:			
	52 resident members @ $10.....		$520 00	
	83 non-resident members @ $5..... J.C. Booth, for two years,		420 00	
	2 life members @ $100..		200 00	
	23 associate members @ $5.....		115 00	
	5 life associate members @ $100.....		500 00	
	1 non-resident (annual contribution).....		25 00	$1,780 00
Dec. 30.	By balance.....			$1,363 04

XXXVII.—Analysis of Mine Water from the Lead Region of South-west Missouri.

BY CHAS. P. WILLIAMS, PH.D.

(Read, Dec. 7, 1876.)

In Jasper County, south-west Missouri—the scene of active lead mining and smelting operations—the galenite occurs in certain members of the Archimedes limestone (subcarboniferous age). The mineral is associated with sphalerite and calcite, as the principal gangues, but the deposits contain, also, dolomite, pyrites, and bitumen. The secondary or later species, noted as resulting from the chief minerals, are cala-

mine, smithsonite, cerussite, and limonite as the more abundant (and in the order of their abundance), besides the rarer species, hydrognicite and pyromorphite.

The results of analysis of two lots of mine water, from the pumping on two successive days from the main shaft, may not be without interest in connection with a study of the genetic relations of the later species with those of older origin. The main or pump shaft is eighty-five feet in depth, and drains a radial distance of a little less than half a mile, or, more nearly, about five hundred acres of lead-producing area, worked by a number of smaller shafts or "diggings" of individual miners.

The results obtained are expressed in grains per gallon of 231 cubic inches, and are as follows:

Sodium chloride	0.16032	0.18094
Sodium sulphate	0.49009	0.48331
Potassium sulphate....	0.31879	0.33772
Calcic sulphate.....	27.98303	28.31665
Magnesic sulphate.....	2.74152	2.23635
Baric sulphate.....	0.08164	0.07115
Zinc sulphate	13.14142	13.08099
Cupric sulphate.....	0.01711	0.01171
Aluminic sulphate	0.58649	0.69906
Calcic carbonate.....	4.58545	4.48954
Ferrous carbonate	2.29817	2.73376
Manganous carbonate ..	Trace.	Trace.
Arsenious acid	0.11887	0.15193
Antimonous acid	0.12232	0.13022
Silicic acid	0.81645	0.64033
Organic matters.....	4.14058	3.63904
Total solids.....	57.60315	57.20170

The copper, arsenic, and antimony were obtained by the evaporation of four litres of the water, and no trace of lead could be found in the residue.

The presence of baric sulphate, though in small amount, is noteworthy, since neither barite nor any

species containing barium has ever been noticed in any of the deposits of the south-western lead region. Barite is, however, a common gangue of the lead ores in the central and south-western regions, where the deposits are of lower silurian age.

The antimony and copper may be accounted for by the presence of these metals in small amounts in nearly all the galenite specimens obtained from the deposits of Jasper County. With eight specimens of carefully selected and apparently pure galenite from the shafts in the vicinity named, I obtained the following percentages of the two metals:

	Antimony, per cent.	Copper, per cent.
I.	.07429	.00478
II.	trace.	nil.
III.	nil.	nil.
IV.	.04912	nil.
V.	.32184	.04232
VI.	.03323	.01038
VII.	.02784	.03724
VIII.	.00709	.01517
Mean	.06418	.01374

The sphalerite from the same locality also shows traces or small amounts of antimony and copper, and in many instances traces of arsenic. The latter is rarely present in the galenite of south-west Missouri.

ROLLA, MO., Sept. 27, 1876.

XXXVIII.—CONTRIBUTIONS TO VOLUMETRIC ANALYSIS.

Second Paper.—On a New Mounted Burette.

BY P. CASAMAJOR.

(Read, Dec. 7th, 1876.)

NOTE.—Since reading this paper before the American Chemical Society, I have found that in the essential characteristics of this burette, I had been anticipated. In the new work of E. J. Maumené, *Traité Théorique*

et Pratique de la Fabrication du Sucre, at p. 482, volume 1st, is a wood-cut, accompanied by a description, in which the liquid of the burette is displaced by a plunger, and it drops out of the instrument from a small beak at the top of the outer tube. This burette is attributed to E. J. Maumené, the preface of whose book bears the date:—Paris, September, 1876.—P. C.]

At the last meeting of this Society, I described and exhibited a new burette of the portable class. This evening I will solicit your attention to another new burette of the class called mounted or permanent.

Burettes of this class have many advantages over portable instruments. For one thing, they can be made much longer, so that, for the same degree of minuteness in their scales, they are able to hold much larger quantities of liquid, and consequently do not require to be replenished so often. They are also less liable to breakage than portable instruments, as they are firmly held in a stand, and are not so subject to accidents from handling. Instruments of this class have, however, a serious defect in common, which is that they have an opening at the bottom, from which the test solutions run out, the flow being regulated by a valve or cock, which generally lets the contents leak out at improper times. Even when the key of a glass cock fits perfectly, if it is sufficiently loosened to allow it to work with nicety, enough liquid may escape around the key and remain adhering to the instrument to afford inaccurate results.

Dr. Mohr's burette is not open to this objection, but it is ill-adapted to hold many of the solutions used in volumetric analysis on account of the perishable nature of its rubber tube.

After trying for a long time to contrive a valve or cock not liable to leakage, I turned my attention in another direction, and the result is the combination I present to you this evening, which shows a mounted burette without a valve or a cock. (See Fig. 1 and Fig. 2.)

Fig. 2

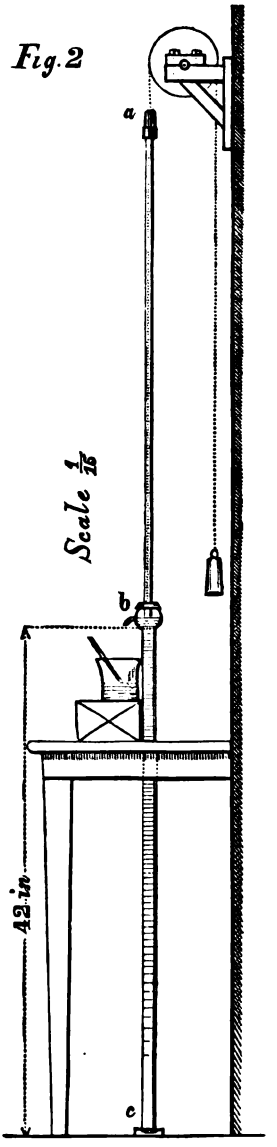
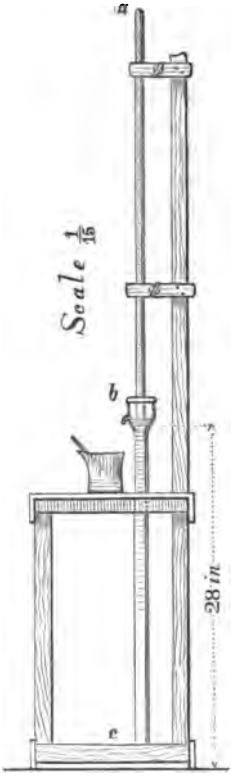
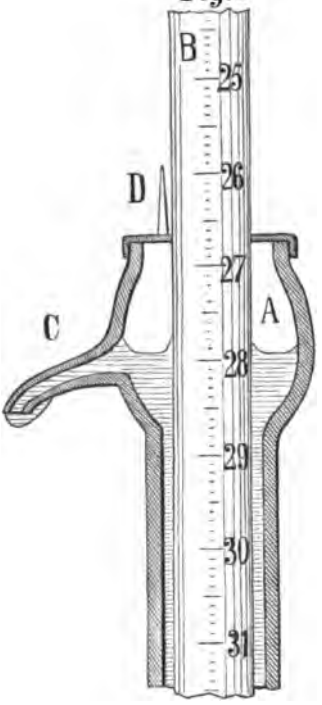


Fig. 1



This result has been accomplished by dividing the burette into two portions; one, which I will call the outer tube, holds the test solution, while the other, which is the inner tube or plunger, bears the graduated scale. As this latter portion sinks into the outer tube it displaces a certain volume of liquid, which finds its way out through the little beak C (Fig. 3).

Fig. 3



(Actual size.)

The plunger-tube being a plain cylinder, has nothing in its shape that deserves attention. It is not so, however, with the outer tube, whose upper portion is expanded and provided with a beak. This portion is represented in Fig. 3, in which A is the outer tube, B the plunger, C the beak, belonging to the outer tube, and D the index. In this figure I have endeavored to give every detail that is necessary to obtain single drops when the plunger is properly lowered. The object of enlarging the upper portion of the outer tube is to prevent any variation in the surface of the liquid. If the outer tube was not made larger at this part, the plunger tube, as it moved down, would not keep

equally distant from every portion of the inner surface of the outer tube. Whenever the distances varied, the shape of the surface of liquid would vary also, rising as the sides of the tubes drew nearer together. The consequence of this would be that for a downward movement of the plunger, sufficient to afford a drop, sometimes no liquid would fall, and, at other times, several drops would fall in succession. By widening the upper portion of the outer tube the surface of the liquid remains the same for all positions of the plunger.

The shape taken by the liquid at the top of the outer tube is represented in Fig. 3. We may notice that the surface of the liquid between the plunger and the outer tube forms a ring, the liquid rising slightly as it touches the glass surfaces. At the end of the beak there always remains a small particle of liquid, which ought to spread partly on the under surface of the beak, as shown in Fig. 3. The liquid, with an annular surface between the two tubes, that which fills the beak, and the small portion adhering to the end of the beak, form altogether a system whose equilibrium is very easily disturbed. When the inner tube is pushed down sufficiently, so that the additional volume that enters in the liquid is equal to about $\frac{1}{20}$ of a cubic centimetre, the small volume of liquid at the end of the beak increases perceptibly, and a drop escapes. Unless the beak is so small as to remain entirely full of liquid, and unless the end of the beak is such that a small volume of liquid adheres to it exteriorly, delicacy of equilibrium cannot be obtained, and the burette will not respond with readiness and regularity to very small downward motions of the plunger.

As glass tubes are not made cylindrical, but slightly conical, an accurate graduation could not be obtained by taking the whole volume of a tube between two points, situated near its extremities, and dividing the space equally into cubic centimetres. The best plan is

to divide a long tube into several equal portions, each representing a known number of centimetres, and afterwards subdivide each portion into centimetres and fractional parts. The plunger of this burette was divided into portions of 10 cubic centimetres, and each such portion was subdivided into centimetres and tenths. To effect this, the first step was to take a long and narrow test-tube, which was gauged by placing in it 10 cubic centimetres of water, and marking the surface of the liquid on the side of the tube. This tube, after being emptied and dried with bibulous paper, was ready for use. The outer tube of the burette being filled with water so that a portion drops out of the beak, the plunger, with its bottom closed, but its top still open, is lowered gradually until a few drops have started again from the beak. This is the starting-point which is marked on the plunger opposite to an index, which may very conveniently be placed on a cap covering the outer tube (see D, Fig. 3). The mark on the tube may be made with a file, previously moistened with spirits of turpentine or petroleum, to prevent the abrasion from cracking the glass. In the next place, the test-tube, capable of holding 10 c.c., is placed under the beak, and the plunger is lowered until the test-tube is filled up to the mark designating 10 c.c. Another mark is then made on the plunger-tube as before, and the operation is repeated until the bottom of the plunger touches the bottom of the outer tube. After every volume of 10 c.c. has been measured, the test-tube is dried with bibulous paper, to get it ready for the next measure. When the operation is ended, the result is a series of marks on the plunger, between which its outside dimensions are equal to 10 c.c. Now a long and narrow strip of paper is taken, and the distances between the marks on the plunger are transferred with a compass on the paper. After this, each space is divided into 10 equal parts, which are again subdivided into 10 equal parts,

the smaller divisions representing tenths of cubic centimetres.

The next step is to introduce the paper scale into the plunger-tube, which was found to be a difficult operation, as the strip of paper would not go in straight on account of its great length. The difficulty was overcome by pasting the strip of paper to the outside of a glass tube, whose diameter was small enough to allow it to slip easily into the plunger-tube. A little wad of paper or cotton should be placed in the plunger-tube before introducing the tube bearing the scale, to prevent a sudden shock from cracking the tubes.

The scale should be placed on the narrower tube in such a way that, when lowered in its place, the divisions of the paper scale corresponding to 0, 10 c.c., 20 c.c., etc., may be found opposite to the file marks on the plunger-tube. Afterwards, the top of the plunger-tube is closed by melting over a lamp.

In Fig. 1 and Fig. 2 are shown two ways of mounting the burette. In Fig. 1, the height from the beak to the bottom of the outer tube is 28 inches, and the instrument may be placed either on the floor or on a table. In the first, the operator must be seated, while in the second case he must stand, so that in every case his eye may be placed opposite to the index. The plunger-tube in Fig. 1 is held by two clamps.

In Fig. 2, the distance between the beak and the bottom of the outer tube is 42 inches. The outer tube reaches to the floor, and it may be protected by a case of wood or metal. The plunger is attached to a flexible band or belt, free from torsion, so that the scale will always remain in front of the index.

The belt passes over a pulley attached to the wall of the laboratory, and the other end of the belt bears a weight to counterbalance the plunger-tube. The operator must be seated when using this instrument. A burette of greater length may be made on the same plan by running the outer tube to the floor, and mak-

ing it high enough to place the index opposite to the eye of the operator when standing.

XXXIX.—Contributions to Volumetric Analysis.

Third Paper.—Correction of the Errors Due to Variations of Temperature.

BY P. CASAMAJOR.

(Read, Dec. 7th, 1876.)

In a paper "On a New Portable Burette," which I had the honor of reading before this Society at our November meeting, I called your attention to the fact that many chemists were unwilling to trust the processes of volumetric analysis, on account of the errors which resulted from the effect of variations of temperature on the strength of the test solutions. These chemists, however, very willingly avail themselves of the reactions of this branch of analysis, and they have adopted the plan of weighing their solutions instead of measuring them. For their use I gave a modification of the portable burette, adapted to being placed in the pan of a balance.

Although it is more accurate to weigh a solution than to measure it, it is difficult to give up the convenience and rapidity which belong to volumetric analysis, and I believe that most chemists prefer to measure their solutions; many even have adopted the opinion that the errors resulting from variations of temperature are so slight as to be scarcely appreciable.

If we compare this opinion with that of the other chemists before mentioned, that these errors are so important that they are unwilling to trust volumetric analysis, it must strike us that, in such an important matter, we should have something better than opinions, and that it is desirable to know, with some precision, what degree of change may result from known variaitons of temperature.

I propose this evening to examine the effect of changes of temperature on the volumes of test solutions, and to give an easy method of correcting the errors resulting from these changes.

At the start I must call your attention to one point, that the reagents used in volumetric analysis are, with few exceptions, in a highly diluted condition, their principal constituent being water, which holds in solution small percentages of acids, alkalies, or salts. A liquid so constituted must expand and contract so nearly like pure water, that any errors which may result from taking for their changes of volume those of pure water, must be so small as to be inappreciable.

To determine the changes of volume of water which correspond to changes of temperature, I propose to make use of the data given by Dr. Matthiessen in his remarkable researches on the expansion of water, glass, and mercury, published in the Philosophical Transactions for 1866.* Dr. Matthiessen found that the expansion of water for a rise of 1° C. was different at different temperatures; that it increased as the temperature increases, although the *rate* of increase diminished. In Table No. 1, given below, are to be found, at every five degrees, the fractions of 1 c.c., which represent the expansion of 1 c.c., for a rise of temperature equal to 1° Centigrade. The numbers given by Dr. Matthiessen range from 5° to 100° C., but I have not made calculations beyond 45°, which is a higher temperature than is ever attained in our laboratories.

* See Brooke's Nat. Phil., p. 761. London. 1867.

Table No. 1.

Expansion of 1 c.c. of water for *rise of temperature of* 1° *Centigrade.*

At	5°	C.	the expansion	is 0.000022.
"	10°	"	"	" 0.000098.
"	15°	"	"	" 0.000162.
"	20°	"	"	" 0.000215.
"	25°	"	"	" 0.000259.
"	30°	"	"	" 0.000290.
"	35°	"	"	" 0.000345.
"	40°	"	"	" 0.000388.
"	45°	"	"	" 0.000428.

For the researches that we have in view, we need the expansions for a rise of 1° at every degree Centigrade, so as to be able to calculate the total expansion from any degree taken as a normal. The numbers representing these expansions may be obtained by taking a series of perpendicular equidistant lines (see Fig. 1), and adopting, as the abscisses, the degrees of the Centigrade thermometer from 5° to 45°, and, as the ordinates, unities representing 0.00001 of a cubic centimetre. The latter numbers are marked on the left in the accompanying figure.

By marking on the vertical lines corresponding to 5°, 10°, 15°, etc., distances from the 0 line representing the expansions for 1° C. at these temperatures, and by connecting these points by a curved line, we are able to find the expansions for every intermediate degree of temperature. This is done by counting on every vertical line the number of divisions from the 0 line to the curve. This curve is the one drawn with a dotted line in Fig. 1. By drawing this curve with great care on a large scale, the following numbers were obtained for the expansion of 1 c.c. of water for an increase of 1° C. for every degree from 5° to 45°.

Table No. 2.

Expansion of 1 c.c. of water at every degree Centigrade from 5° to 45° for a rise of 1° C.

Degree C.	Expansion.	Degree C.	Expansion.	Degree C.	Expansion.
5°	0.000022	19°	0.000205	33°	0.000322
6°	0.000036	20°	0.000215	34°	0.000333
7°	0.000052	21°	0.000224	35°	0.000344
8°	0.000068	22°	0.000233	36°	0.000353
9°	0.000084	23°	0.000242	37°	0.000362
10°	0.000098	24°	0.000250	38°	0.000370
11°	0.000112	25°	0.000259	39°	0.000379
12°	0.000124	26°	0.000266	40°	0.000388
13°	0.000138	27°	0.000272	41°	0.000396
14°	0.000150	28°	0.000278	42°	0.000404
15°	0.000162	29°	0.000284	43°	0.000412
16°	0.000178	30°	0.000290	44°	0.000420
17°	0.000184	31°	0.000300	45°	0.000428
18°	0.000194	32°	0.000312		

The curve which affords the numbers in the preceding table is drawn in Fig. 1 with a dotted line. In the same figure there is another curve drawn with a full white line, which will be noticed hereafter. The dotted curve, which turns its concavity downwards and has quite a regular shape from 5° to 32°, afterwards becomes quite irregular, and, after turning its convexity towards the abscisses from 32° to 40°, becomes concave again with a lesser curvature, which continues pretty regular if the curve is prolonged to 100°. Dr. Matthiessen gave a complicated formula for the volumes from 4° to 32°, and another for those between 32° and 100°.

The figures of the preceding table, which give the expansion of 1 c.c. of water at every degree for a rise of 1° C., will enable us to calculate the total expansion of a volume of water at any temperature, starting from any degree as a normal. Although 25° would be a very convenient temperature to take as a normal, as it represents very approximately the

average temperature of our laboratories, I propose, in common with the generality of chemists and physicists, to adopt 15° as the temperature from which to calculate the expansions and contractions of our test solution.

If we take 15° as a normal, we may inquire what will be the expansion of 1 c.c. of water when the temperature increases to 16°.

In the table given above, we find, opposite to 16°, the number 0.000173, which may be taken as the expansion at that temperature. If we wish to know the total expansion from 15° to 17°, we must take the number 0.000184, placed opposite 17° in Table No. 2, and add it to 0.000173, which will give 0.000357.

In the same manner, to find the total expansion from 15° to 18°, we must add to the above number, 0.000357, the number 0.000194, and the sum will be 0.000551.

We may proceed in the same manner, from degree to degree, up to 45°, by adding the expansion corresponding to each degree in Table No. 2 to the sum of the expansions of all the preceding degrees from 16°.

Below 15°, we will take for 14° the number 0.000150 placed opposite 14° in the preceding table; for 13°, we will add to 0.000150 the number 0.000138, which will give the total 0.000288, and we may proceed in the same manner adding the number opposite to each degree to the sum of the numbers corresponding to all the preceding degrees from 14°, until we reach 5°. We must bear in mind, however, that for temperatures below 15° C. the numbers represent contractions, and are to be subtracted.

The numbers thus obtained will give the second column of Table No. 3.

Table No. 3.—Total Expansions from 15° C.

Degree C.	Absolute Expansion.	Relative Expansion.
5°	0.000878	0.000612
6°	0.000856	0.000622
7°	0.000820	0.000612
8°	0.000772	0.000590
9°	0.000706	0.000550
10°	0.000622	0 000492
11°	0.000524	0.000420
12°	0.000412	0.000334
13°	0.000288	0.000236
14°	0.000150	0.000124
15°	Normal	Normal
16°	0.000173	0.000147
17°	0.000357	0.000305
18°	0.000551	0.000473
19°	0.000756	0.000652
20°	0.000971	0.000841
21°	0.001119	0.001039
22°	0.001428	0.001246
23°	0.001670	0.001462
24°	0.001920	0.001686
25°	0.002179	0.001919
26°	0.002445	0.002159
27°	0.002717	0.002405
28°	0.002995	0.002657
29°	0.003279	0.002913
30°	0.003569	0.003179
31°	0.003869	0.003453
32°	0.004181	0.003739
33°	0.004503	0.004035
34°	0.004836	0.004342
35°	0.005180	0.004660
36°	0.005533	0.004987
37°	0.005895	0.005323
38°	0.006265	0.005667
39°	0.006644	0.006040
40°	0.007032	0.006382
41°	0.007428	0.006752
42°	0.007832	0.007130
43°	0.008244	0.007516
44°	0.008664	0.007910
45°	0.009092	0.008312

In the preceding remarks we have, with a view of presenting the subject in its greatest simplicity, pur-

1.005323, the quotient, 34.819 cc. represents the volume at 15°, corresponding to 35 c.c. at 37°.

Instead of dividing 35 by 1.005323, the operation would be much simplified by multiplying by $\frac{1}{1.005323}$ =0.994705, and a table might be formed in which, opposite to each degree of temperature, would be found a factor, by which to multiply the volume of test liquor used in an analysis.

I have, however, to propose a plan which is easier and more simple in practice, and which will be readily understood by referring to the curve drawn with a full white line in Fig. 1. If we suppose, as before, that the space between the vertical lines represents 1° Centigrade, and if we attribute to the space between two horizontal lines a value equal to 0.0001 c.c., as shown on the right of Fig. 1, we may mark on every vertical line, starting from the horizontal line marked 0, a distance equal to the number 0.0001 c.c., which represents the total relative expansions at the corresponding temperature. We may now connect all the points thus obtained by a curve. This, by referring to Fig. 1, is the curve drawn with a full white line, which presents the appearance of an imperfect parabola with its apex at 6° Centigrade.*

By referring to Fig. 1, we may notice that this curve intersects the horizontal lines corresponding to 0.0005, 0.001, 0.0015, 0.002, 0.0025, etc., at certain points, and that we may easily ascertain to what temperature these points correspond. We will then find that

0.0005	corresponds to	9.9°	Centigrade.
0.	"	15°	"
0.0005	"	18.2°	"
0.001	"	20.75°	"
0.0015	"	23.2°	"
0.002	"	25.3	"

* The reason that the apex is at 6° instead of 5°, is that the expansion for 1° at 5° is 0.000022 (see Table No. 2), which is less than 0.000026, the expansion of glass.

0.0025	corresponds to	27.8°	Centigrade.
0.003	"	29.4°	"
0.0035	"	31.2°	"
0.004	"	32.8°	"
0.0045	"	34.5°	"
0.005	"	36.1°	"
0.0055	"	37.6°	"
0.006	"	38.8°	"
0.0065	"	40.4°	"
0.007	"	41.6°	"
0.0075	"	42.9°	"
0.008	"	44.2°	"
0.0083	"	45.°	"

Now if we take a Centigrade thermometer, ranging from 5° to 45°, and on one side of the column we mark the degrees of temperature, we may, on the other side, mark the places where 1 c.c. becomes 1.0005, 1.001, 0 0015, 1.002, etc. If we have made a volumetric analysis, and used a certain volume of test solution at a known temperature, we will find, on the right of the thermometer, the number by which we must divide the volume of test solution, to have its corresponding volume at 15°. If we have used 63 c.c. at a temperature of 35° C., we may note that the expansion marked on the scale on the right of the thermometer which comes nearest to the required expansion is 1.0045, which corresponds to 34½°, and, on dividing 63 by 1.0045, we will obtain 62.7 c.c.

Instead of dividing by the numbers which represent the expansions at various temperatures, we may, as before, multiply by a number representing unity divided by these expansions. We may mark these numbers on the thermometer as follows:

At	9.9°	Centigrade	1.0005.
"	15°	"	1.
"	18.2°	"	0.9995.
"	20.75°	"	0.999.

At	23.2°	Centigrade	0.9985.
"	25.8°	"	0.998.
"	27.3°	"	0.9975.
"	29.4°	"	0.997.
"	31.2°	"	0.9965.
"	32.8°	"	0.996.
"	34.5°	"	0.9955.
"	36.1°	"	0.995.
"	37.6°	"	0.9945.
"	38.8°	"	0.994.
"	40.4°	"	0.9935.
"	41.6°	"	0.993.
"	42.9°	"	0.9925.
"	44.2°	"	0.992.

In Fig. 2 I give a thermometer marked in this way. On the left are the degrees C., while on the right are the numbers by which we must multiply the reading of the burette, to reduce them to the corresponding volumes at 15° C. If we have used 85 c.c. of a solution, and if the temperature is 32¼° C., we will find that the nearest factor is 0.996, which corresponds to 32.8.° If we multiply 85 by 0.996, the product, 84.66 c.c., is the correct reading at 15° C.

To be able to make use of the corrections afforded by the methods given above, it is necessary, in the first place, that our test solutions should all be titrated at 15°. This can be easily done by using the data already given.

Suppose we have weighed 6.3 grammes of pure dry crystallized oxalic acid, and dissolved the whole quantity in water, this quantity of oxalic acid represents 100 c.c. of a titrated solution of oxalic acid containing 63 grammes to the litre. These 6.3 grammes of acid are capable of saturating exactly 100 c.c. of titrated solution of potassic hydrate containing 56 grammes to the litre. If we have a solution of potassic hydrate of unknown strength, and we wish to discover the volume of it at 15° which will be

equivalent to 100 of the solution containing 56 grammes to the litre, we will proceed as follows:

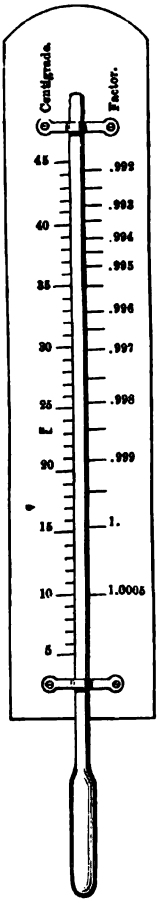


FIG. 2.

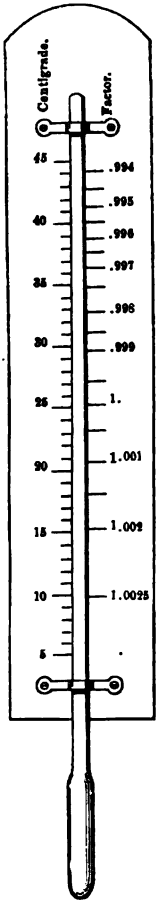


FIG. 3.

If we have used 110 c.c. of the potassa solution to saturate 6.3 grammes of oxalic acid, and if the tem-

perature is 34° C., we may, by consulting the thermometer of Fig. 1, find that 0.9965 is the nearest factor on the scale, and if we multiply 110 by 0.9965, the product, 109.65 c.c., will give the volume at 15° C.

Although, in accordance with nearly universal usage, I have adopted 15° C. as the normal temperature, I have pointed out that 25° is nearer the average temperature of our laboratories. To those wishing to adopt 25°, or any other temperature, as a standard, the table marked No. 2 will afford all the necessary data. If they should desire to take 25° as the normal, and still wish to avoid the trouble of going over all the calculations, I would suggest that by adopting 25.3° as a normal, they can easily obtain the desired corrections by subtracting 0.002, which is the expansion corresponding to 25.3°, from those already given.

The expansions of 1 c.c. will then become:

−0.0025	at	9.9°	Centigrade.
−0.002	"	15°	"
−0.0015	"	18.2°	"
−0.001	"	20.75°	"
−0.0005	"	23.2°	"
0.	"	25.3°	"
0.0005	"	27.3°	"
0.001	"	29.4°	"
0.0015	"	31.2°	"
0.002	"	32.8°	"
0.0025	"	34.5°	"
0.003	"	36.1°	"
0.0035	"	37.6°	"
0.004	"	38.8°	"
0.0045	"	40.4°	"
0.004	"	41.6°	"
0.0055	"	42.9°	"
0.006	"	44.2°	"
0.0063	"	45°	"

From these numbers, by proceeding in the same man-

ner as before, we may obtain a thermometric scale in which 25.3° is the normal, and the factors on the right of the tube are arranged as in Fig. 3.

XL.—Analysis of Potable Waters.

BY H. B. CORNWALL, E.M.

(Read, Dec. 7th, 1876.)

In an article "On some Points in the Analysis of Potable Waters," in the *Journal of the Chemical Society*, London, June, 1876, Dr. Frankland declares, in reference to the method of Wanklyn and Chapman, commonly known as the Ammonia Process, that "any opinion based upon the proportion of albuminoid-ammonia obtainable from a sample of potable water must almost necessarily be erroneous;" and that "it would be preferable to depend upon chlorides and nitrates alone, rather than upon a method of estimation, the results of which do not admit of interpretation." He states also that numerous experiments, by himself and others, have led him to conclude that the process affords no evidence whatever of the absolute quantity of organic matter or of organic nitrogen present in potable water; that it does not indicate even approximately the relative quantities either of organic matters or of organic nitrogen in different samples of such water; and that it affords no indication of the presence or proportion of albuminoid-ammonia, as distinguished from other nitrogenous organic compounds. In proof of these assertions, he cites numerous careful experiments, some of them by Wanklyn and Chapman, on various nitrogenous organic substances, on artificial peaty waters, and on natural waters. Finally, he asserts "that it is therefore entirely useless in the examination of waters for sanitary purposes."

He then claims for the method of Frankland and

Armstrong, the *Combustion Process*, that it alone discloses the proportion of nitrogen to carbon in the organic matter of waters, which information is often of prime importance in reference to the origin of the organic matter; that it is the only method which affords any trustworthy information respecting the organic matters present in potable waters; and that, with certain modifications described in his article, the process can be conducted in any laboratory with a moderate expenditure of time and labor.

I do not propose to question any of the foregoing conclusions, except that which condemns the ammonia process as utterly useless for determining the character of potable waters, but I desire to show from my own experience in the analysis of well waters that the process, supplemented by the chlorine determination, furnishes very reliable indications of their sanitary qualities. In my analyses I have been guided by the general rules laid down in *Water Analysis*, by Wanklyn and Chapman; Third Edition. London, 1874. "When the free ammonia exceeds 0.08 parts per million it almost invariably proceeds from the fermentation of urea into carbonate of ammonia, and is a sign that the water in question consists of diluted urine in a very recent condition. In these instances the water will likewise be found to be loaded with chlorides. Much albuminoid-ammonia (which generally comes over slowly), little free ammonia, and almost entire absence of chlorides, is indicative of vegetable contamination." "If the albuminoid-ammonia amount to less than 0.05 parts per million, the water belongs to the class of very pure water. When the albuminoid-ammonia amounts to .05, then the proportion of free ammonia becomes an element in the calculation." "Free ammonia, however, being absent, or very small, a water should not be condemned unless the albuminoid-ammonia reaches something like 0.10 per million. Albuminoid-ammonia above 0.10 per million begins to

be a very suspicious sign; and over 0.15 ought to condemn a water absolutely. The absence of chlorine, or the absence of more than one grain of chlorine per gallon, is a sign that the organic impurity is of vegetable rather than of animal origin."

In the analyses given below, the free and albuminoid-ammonia have been determined, and also the chlorine, an excess of the latter being regarded as one indication of the presence of sewage. Dr. Frankland himself states that "nearly the whole of the animal matter which gains access to drinking water consists of *sewage*, that is, solid and liquid excrements." He also says that "the decay of vegetation late in the autumn must obviously produce a decided deterioration in the quality of river waters." There can be no doubt that the ammonia process would show the effects either of animal excrementitious matter, or of such decaying vegetation on the quality of water, and just as certainly would it show the presence of dead animal matter. The following analyses are presented to show how well the results of the ammonia process have agreed with what might have been expected from the conditions of each case.

The chlorine in several wells which are very favorably situated and have given no grounds for suspicion, either by actual use or by analysis, was found to vary from 1.6 to 2.3 grains per gallon, and these limits were therefore assumed for the amount of chlorine normal to the soil of this town. When the water of a well in constant use by intelligent persons has given more or less frequent occasion for suspicion, by its taste or odor, it has doubtless at such times been contaminated in some way. Although wells which analysis shows to be impure have frequently escaped suspicion, yet I have not met with a case where a well not condemned by the ammonia process had been at that time suspected by those using it.

The following table shows the results of all of the

analyses which I have made of well waters in this town. Several were selected in order to study the subject; the others were brought for analysis by the owners. Unless otherwise stated, they were made under ordinary circumstances as regards weather. The free and albuminoid-ammonia are given in parts per million, the chlorine in grains per gallon.

Analyses.

Number.	Month.	Free Ammonia.	Albuminoid Ammonia.	Chlorine.
1	Mar.	.016	.036	2.
2	"	.048	.05	2.3
3	Dec.	.004	.07	1.67
4	Oct.	.06	.088	1.6
5	Mar.	.045	.064	2.7
6	"	.04	.07	2.9
7	Oct.	.066	.08	2.5
8	Feb.	.054	.098	2.7
9	"	.04	.14	3.6
10	May.	.04	.126	5.
11	Oct.	.09	.16	1.6
12	Dec.	.045	.19	1.77
13	Nov.	.066	.434	5.05
14	Mar.	2.56	.22	7.4
15	"	1.36	.28	8.5
16	Nov.	.046	.055	7.8
17	Mar.	.21	.28	1.9
18	Oct.	.127	.13	2.

Nos. 1 and 2 are very good wells, most favorably situated, and were selected as such. Nos. 3 and 4 have also not been suspected. The owner of No. 3, however, has another well, No. 12, which had been condemned some years ago by Dr. Henry Wurtz, and he desired now to have both wells examined. No. 3 is admirably situated, but No. 12 is near a stable, not now in use, but surrounded by old manure-heaps. These have been long exposed to the rain, and therefore the ammonia and chlorine is not in excess, but they constantly furnish decaying vegetable matter, as

shown by the abundant albuminoid-ammonia. When these waters were brought for analysis, their respective sources were concealed in order that the method might be tested.

Nos. 5, 6, and 7 might have been classed with Nos. 3 and 4, had not the chlorine been rather large. All three have been suspected. No. 6 is in ground over which bed-room slops are constantly spilled, and lately, after a dry season, gave 3.3 grains of chlorine. No. 7 is near a surface drain, leading from a stable and through ground liable to be covered with slops. No. 8 is near several privy vaults, some in use, others abandoned. One of the family using it, a very strong man, had a severe attack of typhoid fever a few months before the analysis was made.

No. 9 is not far from the site of an old stable, and several vaults were dug up in laying the foundation for a large building near it. The owner, himself an M.D., says that the well caused diarrhœa almost invariably when used by strangers. The abundant chlorine, small free ammonia, and large albuminoid-ammonia are just what might be expected from contamination by old vaults. No. 11 is a second analysis of the same water, taken from the well after several weeks of dry weather in the spring. The albuminoid-ammonia is smaller, partly, perhaps, because the water flowed in from the neighboring soil, and partly because the smaller supply of organic matter was more exposed to oxidation; at the same time, the very soluble chlorides have increased in proportion, as they naturally would in water exposed to some loss by evaporation. Since these analyses were made the well has been abandoned.

No. 12 is the well already mentioned in connection with No. 3. Its character corresponds closely with that of No. 11. The water of the latter had been suspected on account of its odor. The well became dry during the drought last summer, and was cleaned out

and blasted a few feet deeper in the hard slaty rock. After the moderate September rains water collected in it, which soon became bad, and it was analyzed. The owner said the well was on his farm in the country, two hundred feet or more from his barns, and not near any drain. It finally appeared that the well was only fifteen feet deep, and was in a cultivated field. It is easy to see how the chlorine might remain normal, while the washed-out manure and decaying vegetation furnished the large amount of organic nitrogen.

No. 13 was brought for analysis by the advice of a physician. Typhoid fever had been brought to the household by a colored servant, who died there. Another patient using the well also died, and two others were sick at the time the water was analyzed. The well was a favorite with people in the vicinity. After the well was condemned and abandoned the two patients began at once to recover. The excessive chlorine and albuminoid-ammonia, with the somewhat large free ammonia, point to sewage contamination, and the well was situated at a moderate distance from a vault used by all the family. The well itself is on a lot more than a mile from town, and where no difficulty need have existed in obtaining good water. This seems to have been a clear case of infection by means of well-water.

No. 14 is the only well which was not in use at the time of the analysis. The presence of recent contamination from a neighboring vault is very evident. The well had been abandoned because it was evidently bad. No. 15 is no better, receiving as it does the daily soakage from a vault near by. This well was in constant use, and it is scarcely necessary to add that typhoid fever prevailed among the rather large number of persons using it. No. 16 was a surprise. The high proportion of chlorine had naturally prepared me to expect another bad well. On investigation it appeared that the well

was behind an ice-cream saloon, and received the soakage from the waste brine of the freezers. Nos. 17 and 18 are two analyses of the same well, the first made in spring, the second in the early autumn. The well has long been suspected. It is the only one which gave results that seemed difficult to explain. Evidently the well is bad, for the analyses and actual use agree in this, and the analysis indicates animal rather than vegetable organic matter, from the large free ammonia. The chlorine is normal, and, in the absence of any known dilution by rain-water, does not indicate sewage contamination. The well is not far from a cesspool, and may receive some soakage from it, which might be diluted by an abundant supply of pure water, for the well is very deep. Dead frogs have been found in it, and I noticed bones and feathers on the ground immediately above it, showing that slops were thrown there from the kitchen door near by.

My experience thus far has led me to believe that the ammonia process and the chlorine determination will enable any one, after a little practice, to form a correct judgment, not only of the character, but also of the source of any ordinary water. As regards the fact stated by Dr. Frankland, that peaty water gives an "abundance of so-called albuminoid-ammonia, although the existence of proteine compounds—so prone to change—in a material which has been exposed to air and moisture for thousands of years, is clearly an untenable assumption," it may be said that it is very easy to ascertain whether such albuminoid-ammonia really comes from peat. Those who think that such peaty water is not unwholesome can form their opinions accordingly.

THE

AMERICAN CHEMICAL SOCIETY.

XLI.—PROCEEDINGS.

Regular Meeting, Feb. 1, 1877.

THE meeting was called to order at 8.15 P.M., Vice-President Morton in the chair. The minutes of the last meeting were read and approved.

Dr. Endemann, on the part of the Committee on Papers and Publications, stated that for the present Mr. Stanton had withdrawn his paper on "A New Combination of Hydrogen."

The Chairman submitted the following report from the Council: That Art. 8 of the by-laws be repealed, and the following adopted in its stead: Art. 8. All bills against the Society shall be approved by the Council before payment.

That a new article be inserted into the by-laws (to be Art. 9) as follows: A majority of the resident members of the Council shall constitute a quorum. The vote on both these articles to be taken at the next meeting.

That a Committee be appointed by the Chair to make the necessary arrangements for the monthly *conversazione*. Adopted. The Chair appointed as such committee Messrs. C. Pickhardt, Striedinger, and Nichols.

That the Committee on Permanent Rooms be instructed to find rooms at an annual expenditure not exceeding $1,000 for rent, fuel, light, and attendance. Carried.

That in the discussion of papers read before the Society, each member shall be limited to five minutes,

unless an extension be granted by special permission. Passed.

The Chairman called the attention of the Society to the matter of arranging and stereotyping the proceedings, and paying the publishers of the AMERICAN CHEMIST for the cuts that may be required, action on which was deferred.

The first paper of the evening was read: "An Apparatus for obtaining Distilled Water from the Service Steam," by Prof. C. E. Munroe. Dr. Chandler said that in the School of Mines the same end is accomplished by the use of an ordinary steam trap, from which a block-tin pipe conducts the steam into the drying-chambers.

The second paper was read: "On the Estimation of Manganese as Pyrophosphate," by the same gentleman. Dr. A. Behr read the third paper: "On Aconitic Acid in Raw Sugars." Drs. Mott and Doremus being unavoidably absent, the reading of their respective papers on testing milk for adulterations and contributions to the literature of milk analysis, as well as that of Dr. Chandler on the use of the lactometer in milk testing, was postponed until the next meeting.

The following gentlemen were elected members: A. J. Corning, Baltimore, Md., J. D. Hague, San Francisco, Cal., A. Means, Oxford, Ga., John Thalberg, Jersey City, N. J.

The following were proposed: As members: S. T. Douglas, Ann Arbor, Mich., W. E. Geyer, Hoboken, N. J., R. H. Hindley, Racine, Wis., Dr. J. T. O'Connor, N. Y., G. A. Prochazka, N. Y., Dr. E. R. Squibb, Brooklyn, N. Y. As associates: E. M. Kalbfleisch, N. Y., C. Lennig, Philadelphia.

Adjourned.

M. ALSBERG, *Rec. Sec. pro tem.*

XLII.—Description of an Apparatus for obtaining Distilled Water from the Service Steam.

BY PROF. CHAS. E. MUNROE.

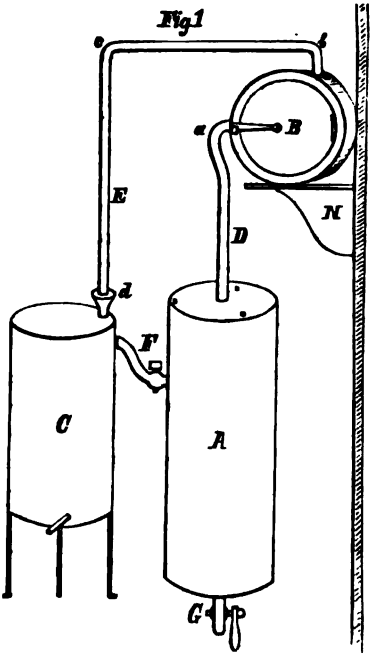
(Read Feb., 1877.)

With the introduction of steam for the purpose of warming laboratories, many plans have been devised for making it useful for experimental purposes. Among other uses to which it has been put is the warming of sand-baths and the production of distilled water. As, however, the steam usually traverses some distance through iron pipes, it becomes necessary to remove from it such impurities as it may have taken up. To effect this, filters of various sorts have been employed, as at Harvard University and elsewhere. Having at the Academy an admirable system for heating the buildings, and even the ships, from centrally located boiler-houses, we naturally sought to utilize it as much as possible, and I arranged a filtering apparatus for the laboratory. This is so arranged that while we use the waste steam from the service-pipes in winter, we may also use the old still in summer. I take the liberty of describing it, hoping it may be of use to others who intend to introduce steam.

The apparatus is placed at one end of the sand-bath, which is the ordinary iron frame affair placed on a brick support which encloses the fireplace. To the left of the grate and beneath the sand-bath is the usual square copper boiler, containing drying-closets, used for generating steam when a fire is employed for heating the sand-bath. To form the floor of the sand-bath an iron sink has been used. When the steam was introduced it was brought through one end of this sink, a coil of pipe being placed on the inside of the sink, and the sand upon the top of this.

The steam was then led off through the other end of the sink to the apparatus to be described.

This apparatus consists of a filter, A, Fig. 1, for cleansing the steam; an air-condenser, with drying-



closet, B, by which hot distilled water is obtained; and a worm condenser, C, for cold distilled water. A is a copper cylinder tinned inside, three feet high and one foot in diameter. Inside are placed four planished copper trays, I, Figs. 2 and 3, perforated with one-half inch holes. These trays are four inches deep, and have such a diameter that they will just slide into the cylinder, and they are furnished with three legs by which they rest upon each other. The top of the upper tray comes within three inches of

the top of the cylinder. These trays are filled with thoroughly washed pumice-stone, coarse lumps being placed on the bottom of each tray and then filled up with pieces about one-quarter inch in diameter. The head of the cylinder, O, can be removed at will to admit of changing the pumice, should it become foul. The service steam enters at H, Fig. 2. This is a spud with one-half inch union placed one and one-quarter inches from the bottom of the cylinder. The exit is by the pipe D, Fig. 1, which is of block tin one inch in diameter, and from the head of the cylinder to *a* is one foot nine inches long. In passing through the cylinder the steam strikes against the pumice, some of it is condensed, and in falling washes the steam which passes through. At the bottom of the cylinder is a pipe, G, Figs. 1 and 2, provided with a stopcock, which is used to carry the condensed water to the sewer. At F, Fig. 1, is a one-inch union to which is attached the pipe from the old copper boiler, which is used when the service steam is cut off. This union is nine inches from the cylinder-head, so that the steam passes through but one of the trays, which is sufficient, as the steam comes through a block tin pipe. As our apparatus is situated it is found most convenient to have F round one-quarter on the left of the cylinder, and H at the back.

Fig. 2

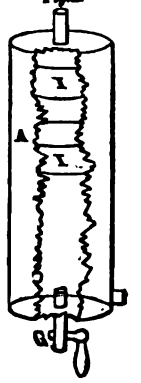
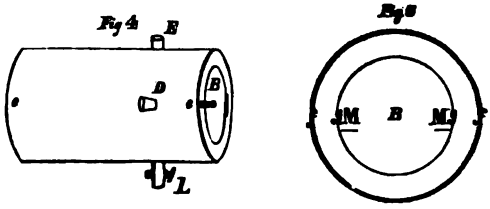


Fig. 3

From the purifier the steam passes to the jacket cylinder B, Figs. 1, 4, and 5. This cylinder is made from copper, and is not only tinned upon the surface enclosing the annular space, but also upon the inside of the drying-closet and both sides of the perforate

shelf. The length of the cylinder from *e* to *e*, Fig. 4, is fifteen inches. The diameter of the outside cylinder from *f* to *f*, Fig. 5, is thirteen inches, and of the inside from *g* to *g*, Fig. 5, is twelve inches. The cylinder extends quite to the back of the condenser, and the space on the front from *f* to *g* is also closed. At



M, Fig. 5, is a shoulder upon which rests a plate of tinned copper perforated with one-half inch holes. The holes serve to hold funnels, etc., when drying. The closet is closed by a door, as shown in Fig. 1. At D and E, Fig. 4, are shown the unions of pipes D and E. They are joined to the condenser nine inches from the back. At L is the stopcock for drawing hot distilled water. The whole rests upon the shelf N, attached to the wall. The pipe E, Fig. 1, which conducts the steam to the worm, is made from block tin, one inch in diameter, and is two inches long from the top of the cylinder to *b*, one foot three and one-half inches from *b* to *c*, and two feet six inches from *c* to *d*. It must be well braced up, as when heated it twists readily. The worm condenser is of the usual form.

When working at the ordinary steam pressure the yield of water is about one hundred gallons per day. By analysis the distilled water was found to contain seven parts of residue in 1,000,000, of which five parts were volatilized on heating to redness. When the old copper still and block tin worm were employed, the water contained fourteen parts of residue in 1,000,000, of which ten parts were volatilized. The Annapolis water used for feeding the boiler contains on an aver-

age seventy parts in 1,000,000, of which about forty-five are volatile.

U. S. NAVAL ACADEMY, December, 1876.

XLIII.—THE ESTIMATION OF MANGANESE AS PYROPHOSPHATE.

BY PROF. CHAS. E. MUNROE.

(Read Feb. 1, 1877.)

THE estimation of magnesium as pyrophosphate had already found favor in the eyes of chemists when Gibbs proposed [*Am. Jour.* (II.), 44, p. 216] the use of hydrodisodic phosphate in the estimation of manganese. Fresenius has criticised this method [*Zeitschrift für Analy. Chemie*, XI., '72, p. 415]; and hence, having had some experience with it, I beg leave to present my results for consideration.

The manganous sulphate employed in the experiments was a very pure salt obtained by separation from a hot alcoholic solution, which yielded it in the form of a highly granular powder, which was dried by exposure to the air. As cobalt is quite difficult of removal from salts of manganese, the salt was especially tested for this elementary substance without a trace being detected. The composition was determined by igniting and weighing as Mn_3O_4 (Mn=55).

	Wt. taken.	Wt. Mn_3O_4 fd.	Per cent. Mn.
1	.8495	.3823	32.43
2	.9864	.4410	32.22

These results are probably as good as the method will admit of, and they show the salt to be $MnSO_4$, H_2O=32.54 per cent. Mn.

In testing the accuracy of Gibbs's method, the analyses were performed as follows: A weighed quantity of manganous sulphate was placed in a platinum

evaporating dish, and dissolved in boiling water; hydrodisodic phosphate was then added in excess, and the whole was allowed to stand on the water-bath, at the boiling point, for about five minutes. The precipitate was now dissolved in the least possible quantity of dilute HCl, and when solution was effected dilute (NH_4) HO was added to complete precipitation, care being taken to avoid any marked excess. After boiling vigorously for from ten to fifteen minutes, the precipitate was again dissolved and reprecipitated as before, using the same precautions. This was boiled for ten minutes, and then allowed to stand for an hour, or longer, at the boiling point. The precipitate obtained in this way was perfectly white, and only acquired a slight pink tinge after exposure on the filter. If, however, a decided excess of (NH_4) HO was used, the precipitate became colored; and if a considerable excess was present, the precipitate was brown. Using the precautions mentioned, a highly crystalline precipitate was obtained, which washed with the greatest ease, Bunsen's method being employed.

In this manner the following results were obtained:

	Wt. taken. $Mn.SO_4, H_2O$	Wt. fd. $Mn_2P_2O_7$	Wt. req. $Mn_2P_2O_7$	Per ct. fd. Mn.	Theory.
3	1.0741	.9007	.9025	32.48	32.54
4	2.8499	2.4088	2.3945	32.74	
5	1.3568	1.1350	1.1400	32.41	
6	1.0837	.9137	.9106	32.65	
7	.7399	.6180	.6217	32.36	
8	.5517	.4596	.4635	32.27	
9	.2317	.1955	.1947	32.68	
10	.3269	.2740	.2746	32.47	
		Mean per ct.		32.51	

The filtrate in every case contained a trace of manganese.

I have alluded to the injurious effects of a large excess of (NH_4) HO, and I present some results which illustrate this. All the other conditions were as in the above mentioned experiments.

	Wt. taken. $MnSO_4,H_2O$	Wt. fd. $Mn_2P_2O_7$	Wt. req. $Mn_2P_2O_7$	Per cent. fd. Mn.	Theory.
11	1.4611	1.1654	1.2276	30.89	32.54
12	1.0003	.8253	.8405	31.96	
13	1.2681	1.0404	1.0610	31.90	
14	.3043	.2461	.2557	31.32	
15	.9878	.8477	.8300	29.11	

In each case the filtrate contained an appreciable quantity of manganese. As before stated, the precipitate began to grow dark even when in the dish, and upon the filter it was very much discolored. In order to examine further the action of (NH_4) HO, I placed a carefully prepared and thoroughly washed precipitate in a platinum dish and boiled it with strong (NH_4) HO. It became almost black, lost its pearly lustre and talcose scaly structure, and was reduced to a mealy powder. On ignition, the residue became white and mealy.

As the test of a practical method of analysis is not alone the results which it gives in the hands of skilful and experienced analysts who devote themselves to an examination of its merits, but those also which it yields in general practice, I offer some results that were furnished me by my friend, Prof. Chas. Hallet Wing. They were obtained by the students of the Massachusetts Institute of Technology in separating iron and manganese. The method pursued was, after nearly neutralizing the acid solution with sodic carbonate, to precipitate the iron as basic acetate, filter and wash with water containing NaCl. The filtrate was evaporated to a small bulk, and a large excess of Na_2HPO_4 added. Then the precipitate was dissolved

in HCl and reprecipitated with NH_4HO. The whole was boiled until the precipitate had changed to pinkish scales, then it was filtered and ignited over the blast lamp, and weighed as $Mn_2P_2O_7$.

A solution containing .1787 grms. of iron and .0517 grms. of manganese in 50 c.c. yielded

Fe.	Mn.	Fe.	Mn.
.1802	.0493	.1779	.0508
.1807	.0506	.1784	.0506
.1780	.0522	.1799	.0524
.1795	.0500	.1799	.0495

The results from the analyses of several other solutions were given, but there is no need of multiplying these examples.

Fresenius has pointed out (loc. cit.) and my experiments confirm the statement that the NH_4MnPO_4 is less soluble in cold than in boiling water, and that it is appreciably soluble in water containing NH_4Cl. Some time ago [Am. Jour., Vol. V., Feb., 1873], Dr. Gibbs suggested microcosmic salt as a precipitant, and it will be seen that by the use of this salt we avoid the difficulties above mentioned, and also the necessity of employing considerable quantities of NH_4HO, which has been shown to endanger the result. It is sufficient to add the solution of microcosmic salt in excess to that of the manganous sulphate; boil vigorously for from ten to fifteen minutes; just neutralize the slightly acid liquid with dilute NH_4HO; allow to cool; filter and wash with cold water. These results illustrate the accuracy of the method.

	Wt. taken $MnSO_4, H_2O$	Wt. fd. $Mn_2P_2O_7$	Wt. req. $Mn_2P_2O_7$	Per cent. fd. Mn.	Theory.
16	.4209	.3540	.3537	32.58	32.54.
17	.3512	.2955	.2951	32.59	

A solution was made which contained .9908 grms. $MnSO_4$, H_2O in 100 c.c. = .3224 grms. Mn. This gave

	Taken = in c.c.	Wt. in grms. Mn. SO_4, H_2O	Wt. fd. $Mn_2P_2O_7$	Wt. fd. in 160 c.c. Mn.	Per cent. fd. Mn.	Theory.
18	25	.2477	.2085	.3231	32.61	32.54
19	25	.2477	.2078	.3221	32.50	
20	25	.2477	.2085	.3231	32.61	
21	25	.2477	.2083	.3228	32.58	
22	25	.2477	.2090	.3238	32.72	
23	30	.2972	.2496	.3223	32.53	
24	30	.2972	.2492	.3218	32.48	
25	10	.0990	.0827	.3203	32.36	
26	30	.2972	.2502	.3229	32.60	
27	10	.0990	.0829	.3211	32.44	
			Mean per cent.		32.54	

There was but a trace of Mn in the filtrate. The precipitate was highly crystalline and perfectly white, only acquiring the faintest possible tinge while drying on the filter. I am disposed to think that this color is due to a trace of a higher oxide of manganese. The precipitation was made in glass evaporating dishes without the least difficulty, and it can also be effected in beakers, if they are embedded in the sand-bath above the level of the liquid.

It has occasionally happened in my experience with students, when they have neglected to separate the filter paper before igniting the precipitate, that a hole was made in the platinum crucible used for the ignition, due probably to the action of reduced phosphorus. I have repeated the experiment several times on foil, and I think this action cannot occur if the precipitate has been thoroughly washed.

In all the analyses the color of the $Mn_2P_2O_7$ obtained was gray. Fearing that this might be due to particles of carbon disseminated through the mass or to other impurities, I prepared some pure NH_4MnPO_4

and carefully separated it from the filter before drying. When ignited, this possessed the same gray color. On treating with HCl it dissolved completely, and hence I am led to believe that it is the characteristic color of $Mn_2P_2O_7$.

My conclusions from these analyses are, that Gibbs' method, especially with HNH_4, $NaPO_4$, furnishes a simple and rapid means for the estimation of manganese, and that the results are sufficiently accurate except for determinations where extreme precision is required.

U. S. NAVAL ACADEMY, December, 1876.

XLIV.—On the Occurrence of Aconitic Acid in Cane Juice and Raw Sugar.

BY ARNO BEHR, PH.D.

(Read Feb. 1, 1877.)

The composition of a raw sugar is generally given according to the following schedule:

Cane sugar	90.40	per cent.
Fruit sugar	3.97	"
Water	2.90	"
Ash	1.27	"
Organic substances other than sugar	1.46	"

The numbers given are of a sugar of middling quality. As we have no way of directly ascertaining the quantity of these "organic substances" they are determined by difference, and the final result contains the combined errors of the other determinations. Besides the uncertainty that is involved in this determination we hardly know anything about the nature of these substances. I am here speaking of raw sugar made from sugar cane. It is quite different with beet-root sugar.

Through a series of admirable investigations, mostly by Dr. Scheibler, the presence of such well-defined substances as oxalic, malic, citric, asparaginic acid, asparagin, betain, arabinic acid, and dextran has been demonstrated in beet-root juice. Concerning cane juice, I know of only one recent investigation, that of Icery, who found in fresh cane juice three different albuminoids, which partly act as ferments on the sugar and cause the juice to spoil quickly.

In the earlier literature of the subject I find only statements concerning gummy, fatty, coloring, albuminoid and similar undefined substances in cane juice and molasses, while Payen states that acetic, malic, and oxalic acid are also present.

In regard to oxalic acid I have had no difficulty in detecting it in any raw sugar, tried in the following way: About 200 grammes of raw sugar are dissolved in a little water, and to the solution strong alcohol is added until a flaky precipitate is formed. This is collected on a filter, dissolved in a little dilute hydrochloric acid, and to the clear filtrate is added acetate of ammonia. The oxalate of lime then separates more or less readily in its characteristic form.

I have prepared some oxalic acid from scales that had been deposited on the worm of a vacuum pan, in which the commercial refined syrup is concentrated. These scales consist almost exclusively of crystalline oxalate of lime.

For studying some of the other constituents of the raw sugar I found the so-called Melado to be a proper material. This is simply cane juice boiled down to a certain concentration, it is then run into hogsheads and, in cooling, partly solidifies by the crystallization of the sugar. It contains all the constituents of the cane juice, with the exception of those that have been removed by defecation, or altered by the boiling process.

The syrup was drained off from the sugar in a centrifugal machine, it was then diluted with water,

acidulated with acetic acid, and precipitated with acetate of lead. The precipitate was well washed with water and decomposed by sulphuretted hydrogen. The filtrate from the sulphide of lead was boiled to get rid of sulphuretted hydrogen, and one-half of it was neutralized with ammonia. After considerable concentration, while the solution was losing ammonia and getting sour again, the other half of the acid was added. At a proper concentration there appeared a salt in crystalline crusts. After several crystallizations from water the salt was decomposed by dilute sulphuric acid and treated with ether. On evaporation the ether left an acid substance in the form of clusters of minute needles. The substance, when dried at 100° C., fused at 172–173° C., and upon analysis furnished the following numbers:

0.6523 g. gave 0.2002 g. H_2O, and 0.9849 g. CO_2, equal to

H : 3.41 per cent.
C : 41.18 "

calculated for $C_6H_8O_6$:

H : 3.45 per cent.
C : 41.38 "

The lime-salt was prepared by neutralizing the acid with carbonate of lime, and was obtained by slow evaporation in small but distinct crystals. 0.8521 g. of the air-dried salt gave 0.6096 g. $CaSO_4$, equal to 21.04 per cent. Ca.

0.6426 g., when heated to 280° C., lost 0.1161 g. H_2O, equal to 18.07 per cent. H_2O.

Calculated for $(C_6H_7O_6)_2Ca_2 + 6H_2O$,

Ca : 21.05 per cent.
H_2O : 18.94 "

The silver-salt was prepared by neutralizing the acid ammonium salt with ammonia and precipitating with nitrate of silver. A precipitate was formed in

heavy flakes like chloride of silver, which, however, in drying on the filter changed into a crystalline powder of microscopic lamellæ. By moderately heating it in a crucible, the salt was decomposed with evolution of heat filling the crucible with a bulky mass of vermicular fibres of silver.

0.5055 g., previously dried at 100° C., left 0.3294 g. Ag equal to 65.16 per cent. Ag, calculated for $C_6H_3O_6Ag_3$, Ag : 65.45 per cent.

When the silver-salt was prepared from the acid ammonium salt, without previous neutralization, it never turned crystalline, and on analysis yielded too little silver; for instance, 64.61, 64.67, 64.74 per cent. Ag was found in samples of different preparations. It would seem as if it then contained some acid silver-salt.

The acid ammonium salt, which I mentioned first, was the monammonic aconitate.

0.3356 g., air-dried, gave 0.3979 g. $PtCl_6(NH_4)_2$ equal to 9.03 per cent. NH_3 calculated for $C_6H_3O_6.NH_4, NH_3$: 8.90 per cent.

Although, according to the results of these analyses, I had no doubt that the substance in question was aconitic acid, yet the melting point, which I found to be 172–173° C., was not in accordance with that of 140° C., which the hand-books assign to aconitic acid. I, therefore, prepared the acid according to well-known methods from citric acid, as well as from the extract of aconitum. The acid from citric acid, purified by means of the acid ammonium salt, melted at 168–169° C. The lime-salt prepared from it contained 20.90 per cent. Ca, and 18.54 per cent. H_2O. Another portion, purified by forming the acid ammonium and lime-salts, fused as high as 187° C.

The acid from aconitum, purified by recrystallization of the acid ammonium salt, fused at 165° C.

This shows that the melting point of the acid has been given decidedly too low by previous investigators. Nevertheless, I am not able to state the exact

temperature at which the pure acid fuses. And it is the more difficult as the acid is decomposed in melting.

In regard to the quantity in which this acid occurs in the raw sugar, I will only state that in one experiment, without counting the loss by manipulation and the portions of the acid ammonium salt, which remained in the mother-liquor, I found the melado to contain 0.149 per cent. of the acid.

After having ascertained the nature of this acid, it was easy to detect its presence in different sugar products. The sweet waters of charcoal filters, used in refining raw sugar, contain it in appreciable quantity. I found the fusing point of the acid prepared from this material to be 171–172° C.

Some molasses sugars gave a peculiarly opaque solution from which, on standing, a sandy sediment came down. This, under the microscope, appeared to be composed of small, well-defined crystals of a rhomboëdral form, which turned out to be aconitate of lime. A large quantity of these crystals was collected in the bag-filters, through which the solution of the raw sugar has to pass before going over the charcoal filters; and I availed myself of the opportunity to prepare a larger quantity of aconitic acid, which had a fusion point of 187–188° C.

Although it appeared highly probable that this acid was a regular constituent of the cane juice, and was produced by the process of vegetation, yet it might be objected that it was formed in the juice after it left the plant by some kind of fermentation or by the action of the lime, which is used in defecation, on the inverted sugar. But I have convinced myself, by direct experiment, that no acid possessing the properties of aconitic acid is formed by the action of lime on inverted sugar. On the other hand I was, through the kindness of Mr. Matthiessen, furnished with fresh cane juice from Cuba, which had been preserved by addi-

tion of carbolic acid. From this I had no difficulty in preparing aconitic acid in its characteristic form by means of the lead and acid ammonium salt. By an accident I lost the best purified portion of the acid before I had analyzed it. A little of it, that was left, but was less pure, had the fusion point 167° C.

To me it seems to be proved that aconitic acid is a normal constituent of the sugar cane, and in this connection it possesses some interest. As yet we know very little of the relations that exist between the organic acids and sugar, and its condensations as gum, starch, and cellulose in the living plant. Now it is a fact worthy of remark, that the two plants which yield the most sugar, the beet-root and the sugar-cane, although very different in other respects, also produce two acids which chemically stand so near together, as citric and aconitic acid, and which contain in their molecule the same number of atoms of carbon that is contained in fruit-sugar.

These relations between the three substances are shown by the following formulæ:

$C_6H_8O_7$ citric acid.
$C_6H_6O_6$ aconitic acid.
$C_6H_{12}O_6$ sugar.

MATTHIESSEN & WEICHERS SUGAR REFINING CO.,
JERSEY CITY, January, 1877.

XLV.—PROCEEDINGS.

Regular Meeting, Thursday, March 1st, 1877.

THE meeting was called to order at 8:15 P.M., Vice-President Morton in the chair. The minutes of the last meeting were read and approved. Dr. Walz requested authority to convey personally the congratulations of the American Chemical Society to the

German Chemical Society on the occasion of the celebration of its tenth anniversary. This was granted. The question of receiving subscriptions for the proceedings of the Society was referred to the Committee on Papers and Publications. The advisability of admitting guests to the *conversazioni* having been discussed at some length, the matter was referred to the Council. Amended Article 8, and new Article 9, of the By-Laws, were adopted as recommended by the Council at the last meeting. The Committee on Permanent Rooms reported progress.

The following were elected:

As members.—S. T. Douglass, Ann Arbor, Mich.; Wm. E. Geyer, Hoboken, N. J.; R. J. Hindley, Racine, Wis.; Dr. J. T. O'Connor, N. Y.; G. A. Prochazka, N. Y.; Dr. E. R. Squibb, Brooklyn, N. Y.

As associates.—E. M. Kalbfleisch, N. Y.; C. Lennig, Philadelphia.

The following were proposed:

As members.—Dr. C. O. Cech, Berlin, Germany; Spencer Borden, Fall River, Mass.

As associates.—Dr. T. J. Charlton, Savannah, Ga.; O. W. Donner, Brooklyn, E. D., N. Y.; J. A. Donner, Brooklyn, E. D., N. Y.; Henry Havemeyer, N. Y.; Fred. Heller, Newark, N. J.; Franklyn A. Kalbfleisch, N. Y.; Albert M. Kalbfleisch, N. Y.; G. H. Nichols, N. Y.; A. L. Sieghoertner, Jr., Brooklyn, E. D., N. Y.; Henry Merz, N. Y.; E. Schroeder, Jersey City, N. J.; J. H. Stursberg, Brooklyn, E. D., N. Y.

Dr. Mott read the first paper of the evening, "Testing Milk for Adulterations," giving numerous data regarding the composition of milk, the accuracy of some of which was, however, disputed by Dr. C. A. Doremus, who read the second paper, "Contributions to the Literature of Milk Analysis." This paper called forth a lively discussion, in the course of which Dr. Waller stated, that the shaking of milk reduces the specific gravity through the absorption of air.

Dr. Doremus furthermore said that on mixing different samples of milk very carefully, a contraction takes place. After numerous remarks of a rather personal nature, called forth by statements of Dr. Doremus, the third paper was read by Dr. Chandler, "On the Use of the Lactometer in Milk Inspection."

Owing to the lateness of the hour, the reading of Mr. Striedinger's paper on "Detonating Submerged Nitro-Glycerine Compounds by Means of Concussion" was postponed until the next meeting.

Adjourned.

M. ALSBERG, Rec. Sec. *pro tem.*

XLVI.—CONTRIBUTIONS TO THE LITERATURE OF MILK ANALYSIS.

BY CHAS. A. DOREMUS, PH.D.

(Read March 1, 1877.)

WE are going over in New York at present much the same ground in the discussion of milk adulteration and its detection that has for many years engaged some of the most prominent chemists of Europe, and to those familiar with the literature of this most vital subject this is strikingly apparent.

Some years ago in Paris, and more recently in London, the milk supply received most careful attention, and out of the many researches and investigations have sprung the present systems of control.

In the fall of 1875 apparently new light burst upon the field, and with great assurance it was proclaimed: "We found that the sp. gr. of 1029* is a little lower than *any* healthy unadulterated milk produced in this

* In all sp. gr. or hydrometer readings the temperature of 60° F. is to be understood.

part of the country, and we selected a sp. gr. of 1029 for our standard of wholesome, unadulterated milk, aware of the fact that *no* healthy milk would be as low as that. The sp. gr. of genuine milk varies from 1029.5 to about 1034.5 in this locality. We have *never* found *any* unadulterated milk which registered as low as 1029, consequently we considered ourselves perfectly safe in making that a standard." *

These statements were but short lived, for now, scarcely a year from their birth, they stand contradicted by their author. From two numbers of the *City Record* of June and July, 1876, we learn that milk from cows "apparently in good health," and well fed on pasture, gave milk of a sp. gr. in twelve cases as low as 1029. We have purposely quoted the words "apparently in good health," since they were used by the experts who conducted these investigations. These experts, chosen from a corps of assistants, were deputed to examine milk in the neighborhood of New York. They were especially instructed in the use of the instruments by means of which the sp. gr. was to be determined, and cautioned to ascertain all the facts they could as regards the health, food, age, condition, etc., of the cattle. These experts agreed that they could not detect anything abnormal in the cattle, and with the exception, owing to a dry season, of a few, all were nourished on good pasture, and that out of all the number only those giving milk *below* 1029 were considered in ill health.† The cattle were then regarded normal, as they naturally should be, since the results of these investigations were published in corroboration of an adopted standard. We must refuse, however, to accept them as reliable evidence in support of the theory that no healthy milk ever falls below 1029—refuse to accept them as affording conclusive evidence even in re-

* People *vs.* Kneib., P. 35.

† J. T. O'Connor, People *vs.* Schrumpf.

gard to the sp. gr. of normal milk, for these reasons: *

That the author of the first supposed axiom regards the tests as made with cattle in an abnormal condition of health, while his subordinates, the real investigators, accept them as normal; and for the additional reason that no less a person than Prof. Silliman, who, versed in the foreign literature of this subject, and from his own researches, was so ably qualified to judge of the tabulated results, when asked his opinion concerning one of the herds, was very positive in asserting that from the results shown in the *Record* he considered that the cattle were decidedly "under abnormal conditions of either health or food."†

We find ourselves, therefore, confronted by a dilemma—either the tests proving 1029.5 (101.5 Lac.) as the lowest gravity are contradicted by experiments showing milk to range in many cases as low as 1029 (100.00 Lac.), or we must consider these last tests as made with abnormal cattle. But these abnormal cattle were produced in evidence to show that genuine milk from *healthy* cows was always above 1029, and the cows must therefore be regarded as normal.

Thus we have, as a result, one and the same authority bringing forward one and the same herd as both normal and abnormal, and standing contradicted in either position he assumes, viz., if normal, by Prof. Silliman, or if abnormal, by the men who saw the cows, tested their milk, and pronounced them healthy and well fed.

To ascertain from personal experience, and to verify previous researches, several trips to one of the milk-producing districts of this State were made, both in 1875 and 1876. In all the experiments we propose to lay before you for consideration, the following was substantially the mode of collecting the vari-

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* Direct Ex., Schrumpf Case.

† B. Silliman, People *vs.* D. Schrumpf.

ous samples. The analyst himself was present at the milking of all the cows except those which gave milk in December, 1876. In these cases a trustworthy and competent assistant on one occasion, and two assistants on a second, procured the samples direct from the cows. The samples were of the whole milking (care being taken to see that the milker did his work properly), were of the well-mixed milk, were tested at oftentimes several degrees of temperature for sp. gr., and always once at 60° F. These tests were sometimes repeated at a later period both by the hydrometer and the sp. gr. bottle. All the precautions possible were taken to prevent any contamination by any substance, liquid or solid. The person collecting the samples had direct supervision from the time of milking to the end of the analyses that were made. As these samples were for use as exhibits in a case at law, unusual precautions were taken to prevent any contamination.

Naturally the food of the cows was a matter that presented itself from the first. One but slightly familiar with the subject of animal chemistry would regard that as a matter most worthy of notice. The food was in almost every case that supplied by nature, viz., pasture, and only those cows from which milk was obtained in midwinter received nutriment that would affect the character of the milk to any degree, and if it did affect it, it would certainly not render it abnormal.

In one series of investigations the age, time of calving, etc., were noted, and the data thus obtained would, of course, be applicable to all samples taken from the same cows, and before the birth of the next calf.

Analyses were made in many cases in addition to the direct determination, by weight, of the sp. gr. in verification of the hydrometer readings.

As the result of these investigations the following tables have been compiled:

Number.	Name.	Farm.	Breed.	Age in 1876.	Specific Gravity at 60°. Experiment or cal. 100° L. = 1028.5.			
					Morning.	Evening.	Morning.	Morning.
1	Goat.....	Uncle R.	Native.	6	1030.4*	.....	.....	.....
2	Indiana	"	"	...	.....	.....	.....	.....
3	Belt.....	"	"	...	.....	.....	.....	.....
4	Star.....	Mulford.	"	10	24 1029.6*	1029.1*	1027.85*	1029.5*
5	Bob-tail.....	"	"	11	39 1027 7*	1023.9224	.....	.....
6	Red.....	"	"		* 1031.1*	1029.65*	.....	.....
7	Hetty Ann.	"	"	12	... 1031.50*	.....	.....	.....
8	Sukey.....	"	"		.....	.....	.....	.....
9	Pikery.....	"	"	12	... 1031.25*	.....	.....	.....
10	Rider.....	"	"	4	... 1029.1*	1028.25*	.....	1029.32*
11	White	"	"	4	... 1026.345	1023.629	.....	.....
12	2 Cows.....	Clark.	Alderney and Native.	...	.....	.....	.....	.....
13	Cherry.....	Uncle R.	Native.	4	... 1031.5*	.....	.....	.....
14	Scrawny....	"	"	4	... 1029.1*	.....	.....	.....
15	Spot.....	"	"	4	... 1029.6*	.....	.....	.....
16	Brindle.....	"	"	4	... 1029.9*	.....	.....	.....
17	Mooly	Mulford.	"	4	... 1029.4*	1030.*	1028.25*	1028.25*
18	Dumplin....	"	"	4	... 1032.65*	1030.*	.....	.....
19	Andre	"	"	4	... 1030.70*	1029.6*	.....	1029.6*
20	Cherry.....	"	"	4	... 1030.40*	1032.6*	.....	.....
21	Yaller	"	"	4	... 1028.5*	1027.47	.....	1029.1*
22	Black.....	"	"	4	... 1030.4*	1029.1*	1023.4*	1022.55*
23	Sheeny.....	"	"	4	... 1031.0*	1029.5*	.....	.....
24	Spot.....	"	"	4	... 1030.2*	1029.6*	.....	.....
25	Fanny.....	"	"	4	... 1028.0*	1028.5*	.....	1026.20*
26	Frank.....	"	"	4	... 1032.65*	1032.1*	.....	.....
27	Charlie.	"	"	12	.....	.....	.....	1030.85*
28	Blue.....	"	"	4	.....	.....	1032.65*	1031.8*
29	Gypsie.. ...	"	"	4	.....	.....	.....	1030.4*
30	.....	Clark.	¾ Ayr., ¼ S. Horn.	3	....	1026.33*	.....	.....
31	.....	"	Native.	12	.....	1030.2*	.....	.....
32	.....	"	Jersey.	4	.....	1028.5*	.....	.....
33	.....	"	Ayr.	2	.....	1030.4*	.....	.....
34	.....	"	⅞ Ayr.	3	.....	1030.2*	.....	.....
35	.....	"	½ Ayr.	5	.....	1030.4*	.....	.....
36	.....	"	½ Ayr., ½ Alderney.	2	.....	1029.4*	.....	.....
37	.....	"	½ Ayr.	3	.....	1030.70*	.....	.....
38	.....	"	⅜ Ayr., ⅝ Native.	13	.....	1030.2*	.....	.....
39	.....	"	⅝ Ayr.	3	.....	1031.5*	.....	.....
40	.....	"	Native.	12	.....	1028.8*	.....	.....
41	.....	"	½ Ayr.	3	.....	1030.2*	.....	.....
42	.....	"	Native.	12	.....	1028.25*	.....	.....
43	.....	"	½ Ayr., ½ Native.	2	.....	1030.70*	.....	.....
44	.....	"	½ Ayr., ½ S. Horn.	14	.....	1032.65*	.....	.....

In Table No. I. a list of the cows examined is given, in all 44 different cows. The milk from these animals was obtained on Sept. 15th, 1875; Sept. 23d, 1876; Dec. 18th and Dec. 24th, 1876. We have thus the records in many instances of two successive years at about the same date, and in others of two successive years and successive visits in one and the same year. No single dairy was selected, but three farms were visited. The food of all but the twelve cows whose milk was obtained in December, 1876, was pasture, this part of the State, Orange Co., is noted for its fine pasture, one or two cows receiving some slight addition of hay, or pumpkins. In December the cattle were necessarily stall-fed, but not by any means at a starvation rate—oat-straw and hay being the diet.

The breeds vary from the native cows through all

TABLE III.

No.	Water.	Solids.	Solids not Fat.	Fat.	Casein Sugar.	Ash.	Lac. 60°	Sp. Gr.
4	85.83	14.17	10.71	3.46	9.62	0.70	97.25°	1028.24
5a	87.57	12.43	8.12	4.31	7.78	0.54	92	1026.89
9	85.3	14.7	8.43	6.27	.....	.....	95	1027.74
21	81.316	18.684	8.209	9.475	8.373	0.836	94	1027.47
11	87.046	12.954	8.617	4.337	7.721	0.896	92	1026.345
11	86 078	13.922	7.823	6.099	7.058	0.765	85	1023.629
10	86.618	13.382	7.725	5.557	7.097	0.728	99	1028.25*
5b	90.125	9.848	6.931	2.917	6.243	0.688	88.5	1023.922
30	87.646	12.354	8.064	4.290	7.373	0.691	92	1026.33*
42	87.552	12.448	6.677	5.771	5.919	0.758	99	1028.25*
4	85.054	14.946	11.091	3.855	10.262	0.729	97.5	1027.85*
22	90.668	9.332	7.392	1.940	7.305	0.087	81	1021.4*
17a	84 786	15.214	8.967	6.247	7.990	0.977	99	1028 25*
25	86.970	13.03	8.38	4.65	7.54	0.84	91.5	1026.2*
17b	86.66	13.34	9.89	3.45	8.61	1.28	99	1028.25*
22	91.52	8.48	6.70	1.78	5.81	0.89	78	1022.55*
Av.	86.921	13.077	8.358	4.668	7.65	0.76	92.48	1026.447

grades to pure breed of Ayrshire and Alderney, and the ages, number of calves, and number of months from

* Calculated.

calving show quite as complicated a story. Looking at this table, we see that of the 44 cows 13 gave milk of less gravity than 1029.* Let us look at these particularly, and for this purpose Table No. II. has been compiled. There are nineteen samples placed in this table, sixteen analyses and thirteen separate and distinct cows. A comparison of the analyses shows that three contained between 90–91 per cent. of water, four between 87 and 87.646 per cent. water, four between 86–87 per cent. water, three between 85 and 86 per cent. water, one 84.786, and one 81.316 per cent. water. The average is readily found in the Table No. III., and shows that altogether the milk is above the usual standard adopted in the analysis of milk, as the solids are 13.077 per cent., instead of 12.5 per cent. The average gravity by calculation is 1026.447.

The question presents itself, how much reliance can be placed on the indications of sp. gr. as to the quality of the milk.

Analysis No. 5 and Analysis No. 42 show the following: Water nearly the same in both—only 0.018 per cent. difference. No. 42 contains more fat, less casein and sugar, and more salts than No. 5, yet with all the near resemblance in water and solids there is a difference in gravity, viz., No. 5, 92° Lac.; No. 42, 99° Lac. Evidently in this case the sp. gr. gives absolutely no clew to a difference in composition. Nos. 10 and 17b show, on the other hand, the same sp. gr. and same per cent. of water; but 2.107 per cent difference in fat is unfortunately a point that does not admit of reconciliation with the idea that the quality of the milk is shown by its sp. gr.

Analyses Nos. 11 and 5b are quite remarkable, for in No. 11 we find 13.922 per cent. solids, of which 6.099 is fat, and in No. 5b 9.848 per cent. solids,

* The milk of two cows, No. 12 in the table, is taken as one. The milk from the two had been milked in the same pail.

2.917 of which is fat. The one rich in fat stands lowest, viz., 85° Lac., and the one that would undoubtedly pass as watered stands 88.5°. Both samples, however, were pure; one was rich, good milk, the other undoubtedly poor. Alas, we will find cows in all climes and in all seasons which are poor milkers, but should a farmer attempt to sort his herd by the test of sp. gr. he would have in this case fared badly, since of the two cows, he would most likely have disposed of the better one. Pardon, however, the introduction of a most peculiar case of the attempt to judge, from the sp. gr. of two milks, their composition. In the *City Record* two analyses of milk were published in connection with the researches already referred to. The question was asked a witness which of these two milks, the lowest in sp. gr. or the highest, contained the most water; one was at 100° and the other 95° Lac.; it was quite noticeable that the answer was not ready. If the sp. gr. is a sure test for excessive water, then the one that stood at 95° must undoubtedly contain the most of that liquid; if, however, the milk that stood at 100° really did contain the most water, as seemed likely from the cross-question being asked, and from the interrogator having his hand on the printed analysis, why, then, the sp. gr. was not a sure test. In fact, the analyses proved that the milk of high sp. gr. contained water over and above that which stood at 95°, or 5° below the standard.

In Table No. IV. a *résumé* is given in regard to the cattle which produced milk of low gravity, and shows, as far as the facts were obtained, the quantity of milk given and the sp. gr. at different periods of observation. From this it is most clearly demonstrable that one and the same cow, at different seasons or periods, gives milk of varying gravity. In some cases in the tables of analyses this fact of the variation from time to time is apparent, also as to the chemical composition. There was most serious fault-finding in regard

to the quantity of milk given by some of the cows. Let the fact be remembered, however, that one does not and should not expect to obtain a large yield from cows many months after calving. Lately a printed document has been largely circulated in New York. It contains the argument of the counsel of the Board of Health in the case of milk adulteration, which has been referred to in speaking of the testimony therein offered. In this document the herd of cows whose milk was tested and reported is divided into "milkers" and "strippers," and it is sought to prove that, since some samples of milk were obtained when the cows were at the end of their milking, all samples must be looked upon in the same light.

No disguise was made of the fact that in many cases the yield of milk was small, nor was the fact disguised that the cow's milk of high gravity was also in correspondingly small quantity. At two farms milk in fair quantity, 3, 4, or 5 qts. at a milking (morning or evening) was found, in oft-repeated instances, that fell to as low a gravity as 1023 to 1024.

These questions will be placed before you on a much firmer basis after touching upon the next point. Up to this we have been considering the facts of two series of investigations, and the contradictory statements of two individual investigators. We have the broad assertion that no healthy cow's milk ever falls below the sp. gr. of 1029, and on the other hand the tests, corroborative analyses of the samples of milk obtained and examined, and demonstrating, we think, the fact that under normal food, a healthy condition of the cattle, a fair yield of milk, the gravity may in many cases—in enough cases to remove the idea that they are exceptional—be as low as 1022.55, and average in those below 1029–1026.447.

We shall now start from an entirely new standpoint and take as a statement to contradict that made in the trial of the People *v.* Daniel Schrumpf. One of

the witnesses for the prosecution was asked this question in direct examination:

"From your reading and observation, and the experiments you have caused to be made, has there been any experiment or test of milk from a sound, healthy cow that under normal circumstances would fall below a hundred on the lactometer by the standard of the Board of Health?"

The answer was:

"I do not recollect a case in which any cow under normal circumstances produced a sample of milk which stood below 1029, or 100 on the lactometer of the Board of Health." *

Prof. Benj. Silliman was asked what the average was between the maximum and minimum sp. gr. of milk from healthy cows in normal circumstances, and answered:

"According to the best of my memory, I should say a fair statement of the general average, throwing out extremes as exceptional, would be from 27 or 28 thousandths as the minimum, to 33 or 34 thousandths as the maximum, that is to say, 1027 or 1028 for the minimum, and 1033 or 1034 for the maximum."

Mr. Vaughan, State Assayist for Rhode Island, and Milk Inspector for the city of Providence, testified that cows on Gov. Sprague's farm he had frequently found to give milk of 1028 in sp. gr.

Very conclusive evidence is that furnished by Mr. S. B. Sharples, State Assayer of Massachusetts, and Milk Inspector for the city of Cambridge, in a memoir presented to the American Academy of Arts and Sciences, Dec. 14, 1875. On page 154 he gives a tabulated statement of the analyses of the milks of nineteen different cows, out of which five fell in sp. gr. below 1029. The results of Mr. Sharples's analyses are subjoined, the whole table being given. It will be

* Chas. F. Chandler, direct examination, People v. Daniel Schrumpf.

noticed that cows, "F," "N," "O," "P," and "Q," gave milk below 1029. The following is a *résumé* of their histories:

Cow.	Sp. Gr. Whole milk.	Sp. Gr. Skim milk.	Sp. Gr. Whey.	Cream vol. per cent.	Ash.	Casein.	Sugar.	Fat.	Total solids.	Solids not fat.	Water.
A	1.030			16	.63				13.66		86.34
B	1.031			18	.65	3.40	5.29	6.62	15.96	9.34	84.04
C	1.033	1.031		6.5	.63	2.98	5.40	4.07	14.13	10.06	85.87
D	1.033	1.034	1.030	11	.72	3.01	5.19	4.10	13.87	9.77	86.13
E	1.031	1.030	1.029	9	.65	3.50	4.81	4.41	13.98	9.57	86.02
F	1.027	1.035	1.028	12	.67	3.38	4.47	6.01	14.99	8.98	85.01
G	1.033			9	.71	4.00	4.99	3.95	15.37	11.42	84.63
H	1.031	1.035	1.031	11	.79	5.23	4.80	4.35	15.61	11.25	84.39
I	1.031	1.034	1.030	7	.64	3.46	4.64	4.23	14.18	9.85	85.82
J	1.032	1.034	1.029	12	.74	4.49	4.63	5.95	16.26	10.31	83.74
K	1.029	1.030	1.028	9	.59	3.21	4.82	5.71	14.96	9.24	85.05
L	1.033	1.033	1.030	10	.64	3.00	4.80	4.04	14.05	10.01	85.95
M	1.030	1.029	1.028	4	.60	3.59	4.81	3.07	12.63	9.56	87.37
N	1.028	1.032	1.029	9.5	.64			4.38	13.81	9.43	86.19
O	1.018	1.030	1.024	54	.61	2.35	5.06	11.46	19.34	7.88	80.66
	1.030	1.031	1.030	18	.65	2.91		5.09	15.11	10.02	84.89
	1.028	1.029	1.026	12	.60	2.34	5.02	6.32	14.91	8.59	85.09
P	1.028	1.031	1.028	10	.66	2.57	5.21	4.11	13.43	9.32	86.57
Q	1.028	1.028	1.025	5	.57	2.25	4.82	2.71	11.64	8.93	88.36
	1.024	1.031	1.024	5	.61	2.67	5.11	4.08	13.03	8.94	86.97
R	1.033	1.034	1.026	5.5	.71	3.66	4.73	1.61	11.94	10.33	
S	1.030	1.033	1.026	11	.74	3.58	5.11	5.69	15.88	10.19	84.12
Averages.	1.030	1.032	1.027	12.0 10.0	.66	3.27	4.94	4.86 4.53*	14.49	9.66	85.51
Highest.	1.033	1.035	1.031	54	.79	5.23	5.40	11.46	19.34	11.42	80.66
Lowest.	1.018	1.029	1.020	5	.57	2.25	4.47	1.61	11.64	7.88	88.36

"F." Native cow, six years old; had been milking one week; gave sixteen quarts milk per day. Feed, six quarts of shorts per day, and hay. Owned by John Steele, of Stoneham, and the milk was sold.

"N." Grade cow, half native, half Dutch, three years old; had been milking two weeks; gave fourteen quarts of milk per day. Feed, two quarts meal, four quarts of shorts, and grass. Owned by Frank Steele, of Stoneham, and the milk was sold.

"O." Native cow, five years old; had been milking ten weeks; gave five quarts of milk per day. Feed, one and a half quarts of meal per day, and hay. The first sample of this cow's milk procured was of such

* Omitting the 15th.

an extraordinary character that two other samples were afterwards obtained. These did not equal the first, but were rather better than the average. The cow had been turned out to grass before the second was obtained. She was owned by Wm. Buckman, of Stoneham, and the milk was used at home.

"P." Native cow, eight years old; gave twelve quarts of milk per day. Feed, one quart of meal, grass and hay. Owned by C. S. Wiley.

"Q." Grade cow, native and Devon, nine years old; had been milking seven weeks; gave nine quarts of milk per day. Feed, grass and hay. Owned by C. Wiley. A second sample of this milk was obtained a few days afterwards; it had improved somewhat. The cow had been kept in poor condition all winter, and had not had grass long enough at the time of the first trial to feel its beneficial effects. The milk was used at home.

It is quite plainly seen from these facts that of all the cows referred to by Mr. Sharples, only one of the five giving low gravity milk was in any way abnormal, and she only on account of food. The milk was not even in her case though more than poor; it is far above suspicion of absolute ill health. All the other cattle then, were in prime condition, and the analyses show that in each case the milks were rich and fine. In a subsequent paper read Nov. 8, 1876, before the American Academy of Arts and Sciences, and published in its proceedings,* Mr. Sharples supplements and substantiates his results. "Analyses XVI., XVII., XVIII., and XIX. were of milk yielded by the Ayrshire cow "Model of Perfection." She was eleven years old, and calved Dec. 31, 1875. Evening's milk, Aug. 13, 1876.

The milk was drawn from each teat into a separate vessel, and was brought to me next morning.

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* Vol. XI., p. 105, 1877.

XVI.	Right forward teat,	yield	907. grams.
XVII.	Left forward teat,	yield	577. "
XVIII.	Right rear teat,	yield	680. "
XIX.	Left rear teat,	yield	577. "
		Total yield	2741. "

	XVI.	XVII.	XVIII.	XIX.	Average.
Cream.....	25.	42.	29.	24.	28.1
Sp. Gr.....	1.025	1.024	1.026	1.028	1.0257
Sugar.....	4.09	2.18	3.44	4.20	3.72
Caseine.....	4.48	6.58	5.00	5.59	5.11
Ash.....	.68	.61	.66	67	.66
Solids not fat.	9.25	9.37	9.10	10.46	9.49
Fat.....	5.59	4.43	4.39	3.84	4.68
Total Solids..	14.84	13.80	13.49	14.30	14.17
Water.....	85.16	86.20	86.51	85.70	85.83
	100.00	100.00	100.00	100.00	100.00

These experiments were repeated with another cow, the milk being of a higher gravity, but the same deductions were drawn from both, viz., that each teat may yield a milk differing from the others. No doubt is cast on the health of either animal, nor exception taken to the low gravity. We again quote: "Analysis No. XXIX., Jersey cow 'Henny,' calved July 17, 1876; food, pasture and green fodder, corn, two quarts mixed corn and oatmeal, and one quart shorts per day. Evening milk, Aug. 6, 1876." *

Cream Vol. p. c.....	27
Sp. gr.....	1,027
Sugar.....	4.20
Caseine.....	4.42
Ash.....	0.59
Solids not fat.....	9.21
Fat.....	4.72
Total solids.....	14.01
Water.....	85.99

* Sharples, Vol. XII., p. 109.

Mr. Sharples has therefore in repeated instances found samples of wholesome, rich milk, of a sp. gr. lower than 1029, and published the results of his investigations in a scientific journal, so that they were accessible to all. He refused in one case to testify in court against a milkman because, although the milk was of 1.0255 sp. gr., the analysis left doubt as to whether it was not genuine unadulterated milk. His publications all tend to the establishment of thorough testing of milk, but are strongly against taking as an indication of adulteration the determination of any one of the physical appearances or chemical constituents.

That these are not the only instances in this country we have reason to believe, from the very positive assertions of farmers and dairymen that have spoken to us on the question, and one gentleman was deterred from sending the milk of his fine herd of cows to this city for sale, for fear of fine and prosecution from the Board of Health, as he found the milk given was of lower gravity than their standard. There is abundant evidence, therefore, from tests and experiments made in this country and neighborhood, that cow's milk of fine quality is often of less gravity than 1029.

Let us now turn our attention to European authority. Parkes in his *Practical Hygiene*, p. 216, *et seq.*, says: *

"The specific gravity varies from 1026–1035. A very large quantity of cream lowers it, and after the cream is removed the specific gravity may rise. The average specific gravity of unskimmed milk may be taken as 1030 at 60° F., and the range is nearly 4° above and below the mean." He speaks of the use of the specific gravity to detect adulteration, but says also that it is not perfect. We are now, however, not to lose sight of the assertion that no milk runs below 1029. This he contradicts.

* A Manual of Practical Hygiene, Edmund Parkes, M.D., London, 1866, p. 216, second edition.

George Wilson, M.D., on p. 41 of his *Handbook of Hygiene*,* after speaking favorably of the test of specific gravity, says: "The specific gravity varies from 1028–1032; if it falls to 1026 it shows that the milk is either very poor, or that a certain amount of water has been added." We may supplement here that, if the milk falls to 1026, it may also be rich, wholesome, good milk, as shown by Mr. Sharples's analyses.

Klenke, on p. 493 of his work on adulterations of food,† says: "Die gute Milch muss immer etwas schwerer als Wasser sein, und auf dem normal Areometer ein durchschnittliches specifisches Gewicht von 1026–32, zeigen und zwar bei 15 Grad Celsius, oder 12½ Reaumur."

No other conclusion can be drawn, we think, from the following quotation from Wanklyn:‡ "There hardly ever was an instrument which has so utterly failed as the lactometer. It confounds together milk which is exceptionally rich with milk which has been largely watered; and many a poor French peasant, bringing the best and unadulterated produce of his dairy into a French town, has been ruthlessly stopped by the police, who have dipped their lactometer into the milk, and forthwith sent it down the gutter, as if it had been milk and water," unless it is that the gravity was below 1029, the French standard at one time for purity.

Hassall, in the last edition of his work on the adulteration of food and modes of detecting the same, says, p. 399:§ "As the composition of milk varies, so of course does its specific gravity, but it may be said to range from 1027–1034. On p. 406 two tables are

* A Handbook of Hygiene, Geo. Wilson, M.A., M.D., Edin., p. 41.

† Die Verfälschung der Nahrungsmittel und Getränke, von Hermann Klencke, Leipzig, 1858.

‡ J. A. Wanklyn, M.R.C.S., Milk Analysis, 1874, p. 8.

§ Food, its Adulterations and the Methods for their Detection. Hassall. London, 1876.

given showing the variation of genuine milk morning and evening in specific gravity. Ten cows were taken and the *average* of the morning milks was *nearly* 1029 —five being below 1029—and the average of the same cows' evening's milk about 1027, *all* being below 1029. It will be observed from these tables also that from the gravity no conclusion could be drawn of the amount of cream the milk was capable of giving. The Richmond cows, from which the first six morning and afternoon milks were obtained, were fed partly on grass and partly on grain. The samples were taken from the milk-pail containing the whole of the milk obtained from the cow, and whilst still warm.

"From the preceding tables (p. 406) it appears: That the *specific gravity* of genuine milk, in its ordinary condition, varies between 1026–1031; and that the average specific gravity of the morning milk is about 1029, and the afternoon 1027; but the results of more recent observations gave a variation of from 1029–1034 for genuine milk."

These observations are tabulated on p. 400. There are twelve cows—two giving milk below 1029. Other tables are given where many samples fell below 1029; but as there are no statements as to whether they are of the whole milk, no cognizance can be taken of them except this brief reference.

We now come to a work of very recent date.* It in many parts speaks in favor of using the specific gravity as an indication of watering, but on careful criticism, the fact creeps out that after all for judicial prosecution there is great doubt, especially where the milk produced comes from various sources, such as supplying large cities, if it shall be the only test necessary to procure conviction. But of one point there is no doubt, that many authorities find milk from

* Fleischmann: Das Molkereiwesen, 1876, p. 89.

normally fed and healthy cattle in many cases falling below 1029 in specific gravity.

Goppelsröder, who has devoted himself to this subject for fifteen years, made tests with milk from 197 cows, and the author, Fleischmann, on 123. The cows were all milked in the presence of the analyst.

	Goppelsröder.		Fleischmann.	
over	1034	3 per cent.	1	per cent.
1034–1033	6	"	14	"
1033–1032	13	"	25	"
1032–1031	22	"	26	"
1031–1030	24	"	32	"
1030–1029	18	"	2	"
1029–1028	11	"	0	"
under	1028	3 "	0	"
		100	100	

Fleischmann, not content with his experiments, and wishing to contradict still more fully Goppelsröder's statement, took the specific gravity of milks at many different places, and found the milk generally above 1029, but had to allow that "here and there" samples were found between 1027–28, although he failed to find any lower from what he looked upon as healthy cows. He then makes investigations, resulting, as he interprets them, in his favor as far as commercial milk is concerned; but has the fairness and frankness—alas! too often wanting with some investigators—to acknowledge that, although supported by many authorities on the question of the average specific gravity of milk, he is flatly contradicted by Orthmann, who found the average of fifty-six samples to be 1027.1, and by Pincus and Struckmann, in that they give the specific gravity as varying from 1024.8–1040. Fleischmann attempts to cast somewhat of a slur upon these last results, but, however he may strive, the fact remains that cases, not so few as to be considered as exceptions, are recorded of milk of less specific gravity than 1029.

Need these citations be pursued further? Must it not be conceded that there is abundant evidence showing that far from there being isolated cases of milk of lower specific gravity than 1029, quite a goodly percentage at the lowest in this country, from 15 to 20 per cent. are recorded?

It is claimed by some that in bringing forward samples of milk of lower specific gravity than the officially adopted standard, we would do away with all testing for adulteration, we have on the contrary always contended that a more severe and rigorous prosecution of offenders against the public health and public purse should be instituted; but that in the methods of detecting the frauds, the rights of individual citizens to complete proof should be respected.

In Johnson's Universal Encyclopædia it is stated that by means of the indications of specific gravity over forty cases for watering milk were prosecuted and fined. Is it a fair, honest statement to give to the public? Only two cases of milk adulteration have been tried in this city where the defendants had the support of any scientific testimony, and in one the Supreme Court pronounced the man not guilty on account of insufficient evidence, and the other is now pending the adjudication of the same tribunal.

A very serious charge has been made concerning the sample of milk from the "Black cow" referred to in the tables, and obtained on December 18, 1876. It was stated, and the statement has been largely circulated in a pseudo-scientific form in New York, that it was alkaline in reaction three weeks after the analysis was completed, and that it contained pus. In regard to the first point we may state that the person who gave part of the sample for analysis tasted the milk and found it sour, and that when tested with litmus paper two days after, it was acid. Professor J. W. S. Arnold was requested to examine the samples obtained from the "Black cow" on December 18th and 24th,

and states: "I received from Dr. Charles A. Doremus two bottles containing milk; one bottle was marked 'No. 3,* Black cow,' and the other 'Black,' with the degree of the lactometer. On the 28th of December, 1876, I made a very careful microscopic examination of both samples, in order to detect anything abnormal in them, or either of them. My examination failed to disclose anything abnormal in the character of said milks, or either of them, and in my opinion the same were pure and from a healthy cow. On and after the 28th of December, I made repeated examinations of the said milks, with especial regard to discovering the presence therein of pus. I am perfectly familiar with the characteristics of pus from various animals, including cows, and have made many microscopic examinations of the same. In neither of the said samples of milk did I find a particle of pus."

Before making the analysis of this sample of milk, we examined it microscopically also, and though familiar with the morbid excretions of the human body, and with the characteristics of pus, and such anatomical elements, failed to discover any in this milk, or in the second sample from the same cow. We were unwilling, however, since two experts had said that pus was found, to let the matter rest on our own convictions, but we must surely consider Professor Arnold's statement as conclusive.

We are well aware of the attempt that will be made to shield the employment of the hydrometer in testing watered milk on the use of the average specific gravity of milk; but be it remembered that there are two facts that will not support that. When we find that two milks of the same specific gravity have different chemical composition, and two milks of the same chemical composition have different gravities, how can the average be calculated, or a standard ar-

* No. 3, obtained December 18, 1876.

rived at, even by experiment, that will hold for a criminal prosecution. Late investigations also show that one and the same milk will vary in specific gravity in short periods, where from the temperature remaining sufficiently low, no essential chemical change has taken place.

When criminal prosecution is to follow the seizure of a suspected sample, we claim that, at no great additional expense (and if there were, a criminal prosecution would justify it), much more positive knowledge of the purity or impurity of the sample is attainable. Who should be more zealous in seeking this, than those appointed to watch over the health of a great city?

There must be an error of logic somewhere that permits the prosecution of individuals by tests that we must claim are, at best, at the present time considered doubtful. The Schoeppe case in Baltimore and the case of Mrs. Wharton lacked complete chemical evidence; the analyst, though a man of age and distinction, was severely criticised by his scientific brethren and by the public. Is not the same criticism applicable to experts who gave the weight of their name and position to the condemnation of citizens on evidence far less complete than in the cases above referred to?

Klencke says (p. 511), in his work: "Where, however, a criminal prosecution is to follow, and a fine is to be imposed, it is absolutely necessary that a chemical investigation shall be made." Such a sentiment is found also in the opinion of the Judges of the Supreme Court of New York—Brady, Daniels, and Davis: "If by tests made by scientific men the lactometer or lactodensimeter furnishes only questionable evidence of adulteration, it should not be regarded as sufficient to warrant a conviction. There should be superadded evidence which would remove the doubt, and if analysis be necessary for the purpose it should be made. The milk supposed to be adulterated and

offered for sale can be purchased and so tested that the result must be certain beyond a reasonable doubt. The testimony given on the trial herein and presented on this appeal establishes clearly that such a test can be made. It may be troublesome, but the Board of Health seems to be vested with the necessary power to have it done, and the duty of protecting the community from illegal traffic, of which it is a dangerous element, demands careful and rigid scrutiny. When the proof is certain the punishment should be as severe as the law permits."

AMERICAN CHEMICAL SOCIETY.

VOL. I. PART 2.

THE AMERICAN CHEMICAL SOCIETY.

XLVIII.—Proceedings.

Regular Meeting, Thursday, April 5, 1877.

The meeting was called to order at 8.15 P. M.—Vice-President Chandler in the chair.

The minutes of the last meeting were read and approved.

At a Council Meeting, held April 3d, it was resolved to recommend the following to the Society:

That the custody, distribution and sale of the Society's publications be intrusted to the Committee on Papers and Publications, and that they supply copies at $5 00 per annum, no single numbers to be sold.—Carried.

That members may introduce strangers to the *conversaziones*, the names to be recorded with that of the introducing member in a book to be kept by the Secretary.—Carried.

That the celebration of the first anniversary (April 6th) take place at the next *conversazione* in such manner as the Society may decide upon.—Referred to Committee on *Conversazione* with power.

Mr. Waller, of Committee on Rooms, reports, that the top floor in the building at the northeast corner of Fourth avenue and Seventeenth street is available, at an annual rent of $600.—Referred to Council.

The following were elected:

As members—Spencer Borden, Fall River, Mass.; Dr. C. O. Cech, Berlin, Germany.

As associates—Julius A. Stursberg, Brooklyn; Oscar W. Donner, Brooklyn; John O. Donner, Brooklyn; A. L. Sieghörtner, Brooklyn; Henry Havemeyer, New York; Franklin A. Kalbfleisch, New York; Albert M. Kalbfleisch, New York; G. H. Nichols, New York; Henry Merz, New York; Fred. Heller, Newark, N. J.; E. Schroeder, Jersey City, N. J.; T. J. Charlton, Savannah, Ga.

The following were proposed:

As members—Thomas Norton, Berlin, Germany; A. Penissat, Clermont Ferrand, France; Jos. C. F. Cheever, New York; J. H. Appleton, Providence, R. I.; Chas. Edgar Dwight, Wheeling, W. Va.; T. O'C. Sloan, N. Y.

As associates—Francis Forbes, N. Y.; A. P. Howard, Boston, Mass.; O. B. Stillman, Boston, Mass.; Edward S. Renwick, N. Y.

Mr. Julius H. Striedinger read the first paper of the evening on "Detonating Submerged Nitro-Glycerine Compounds by means of Concussion."

Mr. Casamajor read part first of his paper on "Areometers," which was discussed by Drs. Chandler and Waller.

Dr. Doremus' paper on the "Abnormal Constitutents of Blood in Leucocythemia," was laid over for the next meeting.

Prof. Mallet's paper on "Magnesium Nitride obtained by the Smothered Combustion of Magnesium," was read by title and ordered to be printed.

Adjourned.

XLIX.—On Detonating Submerged Nitro-Glycerine Compounds by Means of Concussion.

BY JULIUS H. STRIEDINGER.

During the course of preparations made for the great blast at Hallett's Point, Hell Gate, the practicability of transmitting detonations, through the agency of water, was made the subject of careful consideration.

Experiments were carried on by the undersigned, under the direction of General Newton, with the ultimate view of ascertaining the feasibility of adding this method of explosion to that derived from the electric appliances. In the following it is intended to present a description of the apparatus used, the experiments made, and the conclusions finally arrived at.

The apparatus itself consisted of an iron bar, lowered into the water by means of two marked lines secured to its extremities, the upper ends of the lines being fastened to two buoys; thus the bar was sustained at the required depth. About five feet below this iron bar the charges were secured to white pine strips lashed to the bar; iron sinkers were hung to the lower ends of the strips. The strips varied in dimensions, one measuring $\frac{3}{4}'' \times 2'' \times 6'$; the other $\frac{3}{4}'' \times 4'' \times 6'$.

The cartridge containing the "20 grain of fulminate fuse" was

always attached to the narrow strip, while the other secondary cartridge, not supplied with an electric fuse, was connected with the wider strip.

The explosion of the cartridge bearing the fuse was determined by the electric current.

Owing to the difference in width of the pine strips, an examination of the wooden *débris* after the blast readily indicated whether the detonation by concussion of the secondary cartridge was effected or not.

The following were the nitro-glycerine compounds used in the experiments:

1. Dynamite No. 1, being a mixture of
   75 per cent. of nitro-glycerine with
   25 per cent. of Kieselguhr.
2. Rendrock, consisting of
   33.4 parts of nitro-glycerine,
   2.4 " charcoal,
   6.7 " sulphur,
   52.8 " saltpetre,
   2.0 " rosin,
   2.7 " wood fibre pulp.

These high explosives, made up into one-pound, and half-pound charges, were put in brass and paper shells, also in rubber bags.

The shells measured two inches in diameter, and six inches in height; the metallic shells being, in addition, provided with a cylindrical neck, one and one-half inches high and one inch wide. The paper cartridges were dipped in paraffine.

When entirely filled, each of these shells just contained one pound of explosives.

For the experiments with one-half pound charges, the brass shells of the above dimensions were half filled with dry sand before the nitro-glycerine mixtures were introduced.

The rubber cartridges had an ellipsoidal form, their width not exceeding two inches. Old gun-cotton bags were used as shells.

All cartridges were well sealed with water-tight cement—a mixture of beeswax, pitch, and tallow—the necks of the metallic shells being in addition closed with corks.

Charges detonated at a depth of about six feet produced very handsome "*jets d'eaux*," which rapidly decreased in height, according as the cartridges were fired in gradually increasing depths; until scarcely any upheaval of water was produced in a depth of thirty feet, and only a few gas bubbles rising slowly to the surface, indicated that the voluminous gaseous products of the explosion had been reduced in bulk, and mostly absorbed by the comparatively cold salt water.

Tabular Statement of Experiments made on the Transmission of Detonation by Water off Hallett's Point, Hell Gate.

Number of experiment.	Date.	Amount and kind of explosive		Description of shell of		Distance apart of cartridges, in feet.	Depth to which cartridges were submerged.	Depth of water where explosion happened.	Results.
		In primary cartridge.	In secondary cartridge.	Primary cartridge.	Secondary cartridge.				
	1876.					Feet.	Feet.	Feet.	
1	Aug. 25	1 lb. dynamite, No. 1.	1 lb dynamite, No. 1.	Brown paper shell, dipped in paraffine.	Brown paper shell, dipped in paraffine.	12	18	34	Both cartridges exploded.
2	do.	do.	do.	do.	do.	12	30	36	do.
3	do.	do.	do.	do.	do.	12	6	30	do.
4	do.	do.	do.	do.	do.	18	6	9	do.
5	do.	do.	do.	do.	do.	18	6	16	do.
6	Aug. 28	½lb. dynamite, No. 1.	½lb. dynamite, No. 1.	Brass can half filled with sand, cylindrical sides, covered with ⅛″ layer of paper, and dipped in paraffine.	Brass can half filled with sand, cylindrical sides, covered with ⅛″ layer of paper, and dipped in paraffine.	18	6	17	Only the primary cartridge exploded; neck of the secondary cartridge blown off.
7	do.	do.	do.	do.	do.	18	30	34	Only primary cartridge exploded.
8	do.	do.	do.	do.	do.	12	30	36	do. Neck of secondary cartridge forced off by explosion.
9	do.	1 lb. dynamite, No. 1.	½lb. dynamite, No. 1.	Brass can	do.	12	6	30	Only primary cartridge exploded.
10	Aug. 29	1 lb. rendrock,	1 lb. rendrock,	Brass can with cylindrical sides, covered with ⅛″ paper wrapping, and dipped in paraffine.	Brass can with cylindrical sides, covered with ⅛″ paper wrapping, and dipped in paraffine.	12	30	37	do.
11	do.	do.	do.	Brass can without paper wrapping.	Brass can without paper wrapping.	12	30	37	do.
12	do.	do.	1 lb. rendrock, and 1 quintuple fuse.	do.	do.	12	30	36	do.
13	do.	do.	do.	do.	do.	12	6	30	Only primary cartridge exploded; neck blown off from secondary cartridge.
14	Sept. 4	½lb. dynamite, No. 1.	½lb. dynamite, No. 1.	Rubber bag of about 2″ in thickness.	Rubber bag of about 2″ in thickness.	12	6	35	Both cartridges exploded.
15	do.	do.	do.	do.	do.	12	30	37	do.
16	do.	do.	do.	do.	do.	18	6	36	Only primary cartridge exploded.
17	do.	do.	do.	do.	do.	18	30	35	Both cartridges exploded.
18	Sept. 7	1 lb. dynamite, No. 1.	1 lb. dynamite, No. 1.	Brass can, cylindrical sides, covered with ¼″ wrapping, and dipped in paraffine.	Brass can, cylindrical sides, covered with ⅛″ wrapping, and dipped in paraffine.	7	4.5	9	Only primary cartridge exploded.
19	do.	do.	do.	do.	do.	2	4.5	9	Both cartridges exploded.
20	do.	do.	do.	do.	do.	5	3.2	9	do.

In many cases when no explosion by concussion of the secondary charges ensued, the necks of their metallic shells were found to have been blown off, and the plastic high explosive appeared reduced in diameter; thus demonstrating that considerable outside pressure was exerted on the secondary cartridge.

The results of the experiments given above tend to justify the following conclusions:

1. Through the agency of water the transmission of detonation is practicable between dynamite charges.

2. The explosion by concussion of the submerged dynamite depends:

a. Upon the character of the cartridge shell (paper and rubber casings communicating the detonation more readily than metallic shells).

b. Upon the distance between the charges, a decrease in the distance between them increasing the probability of detonation by transmission.

NOTE.—A diversity of opinion exists regarding the question, *What causes the transmission of detonation?*

Professor Abel, one of the first authorities on the subject of high explosives, observes:

"That the degree of facility with which the detonation of a substance will develop similar changes in a neighboring explosive substance, may be regarded as proportionate to the amount of force developed within the shortest space of time by that detonation; the latter being, in fact, analogous in its operation to that of a blow from a hammer, or of the impact of a projectile."

And again:

"That the effect of the detonation of one substance in causing the explosion of another, depends not only on the force, but also on the nature of the vibrations developed in the former. The most probable explanation of the observed results being: that the vibrations attendant upon a particular explosion, if synchronous with those which would result from the explosion of a neighboring substance, in a state of high chemical tension, will, by their tendency to develop those vibrations, either determine the explosion, or at least greatly aid the disturbing effect of mechanical force, suddenly applied; while, in the instance of another explosion, which develops vibratory impulses of a different character, the mechanical force applied through its agency has to operate with little or no aid, so that greater force or a more powerful detonation is required, in the latter case, to accomplish the same result."

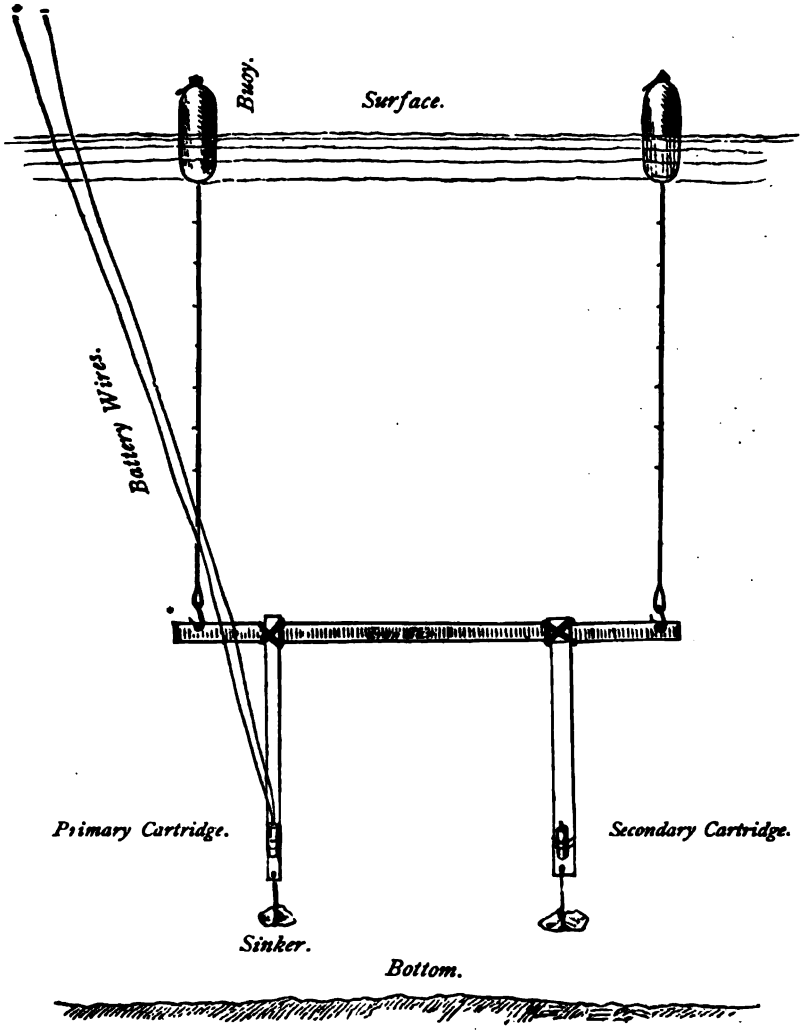
As we derive from our experiments at Hallett's Point sufficient evidence that pressure really was exerted on the secondary charge, due to the detonation of the primary, I respectfully suggest that the following

experiment be made, in order to determine, as near as possible, whether or not the detonation of an explosive substance, submerged in the neighborhood of another, is really the result of compression, arising from the detonation of one of the substances, as we know that compression quickly applied, will generate heat and cause explosion.

For this purpose two cartridges of the same size and material might be selected, their shells to be cylindrical and of brass, and filled with similar explosive compounds.

Let the shell of one of the cartridges be perforated by holes of any given shape, but made in its cylindrical sides; and pieces of brass, larger, but corresponding to those holes, made so as to close them when put inside the shell; the pressure of the explosive compound in the cartridge serving to retain these covers or shutters in their positions; at the same time water-tight cement to be placed around the edges of the holes, to completely exclude moisture.

Now on submerging the two cartridges, placing half way between them a primary cartridge containing the fulminate of mercury fuse, should (while gradually increasing the distance between the three cartridges) the charge in the perforated shell continue to explode, while that in the other does not, then it will be evident that the explosion is due to the higher degree of sudden pressure which the charge received, owing to the more compressible character of its shell; proving, for submerged charges at least, that transmission of detonation is chiefly effected by heating the explosive by compression.


Buoy.
Surface.
Battery Wires.
Primary Cartridge.
Secondary Cartridge.
Sinker.
Bottom.

L.—On Areometers. Part I.

BY P. CASAMAJOR.

The last paper which I had the honor of reading before this society related to the corrections of the errors due to changes of temperature in volumetric analysis, and although the results which I gave found their application in an important branch of chemical science, I am not sure that my paper had otherwise a very close connection with chemistry. The favorable reception of this paper by many members who have expressed to me great interest in its subject, induces me to offer you, this evening, a paper of a similar character on areometers. Such is the constant use made by chemists of these useful and convenient instruments, that I feel I owe no apology for presenting the subject. In the first place, I propose to examine the nature of the scales of the areometers most generally used, and, in the second place, to apply the data obtained by this examination, and those given in the last paper which I read before this society, to the correction of the errors resulting from variations of temperature.

PART FIRST.—SCALES OF AREOMETERS.

A great portion of what I have to say on the scales of areometers, I have published already on several occasions; * and although it is with regret that I have to present you with matter that I have published elsewhere, I have found no way of avoiding it, as otherwise the new matter I have to present would be incomprehensible.

Areometers are formed of two portions, the stem, which bears the graduation, and the bulb, whose diameter is considerably larger, and whose object is to avoid excessive length of the instrument. I must, however, for the purpose of studying the graduation of areometers, discard the bulb, and suppose that we have a geometrical cylinder of indefinite length.

If this areometer A B is to be used for liquids heavier than water, we will suppose that its weight is such that, when immersed in pure distilled water, at the normal temperature, it will sink to a point c, near the top of the cylinder. This is an important reference point in all areometers, as it corresponds to the unity of specific gravities of liquids.

As a floating body is in the state of equilibrium in a liquid, when the weight of the liquid displaced is equal to the weight of the floating

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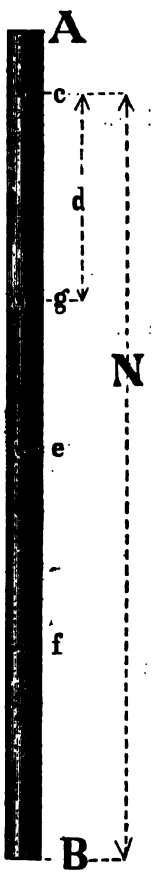
* Testing Sugar Solutions, *American Chemist*, Oct. and Nov. 1873.
On the Formula of Francœur, &c. (ibid.), Feb. 1874.
Expansion of Sugar Solutions by Heat (ibid.), June, 1874.
Nouveau Procédé pour la Détermination du coëfficient de pureté des dissolutions sucrées.—*Moniteur Scientifique*, March, 1877.

body, if we place our cylindrical areometer, which sinks to c in pure water, in a liquid whose specfic gravity is double that of water, it will sink to a point e, placed in such a manner that $Be = \frac{Bc}{2}$ This happens because, in a geometrical cylinder, the distances Bc, Be are proportional to the volumes between these points, and because the new liquid being twice as heavy as water, it takes half the volume to float the areometer. In the same manner, if it was possible to obtain a liquid four times heavier than water, the areometer would sink to a point f, so placed that $Bf = \frac{Bc}{4}$



If now we call the specfic gravity of water 100, and if we place numbers opposite to c, e, f, which express the corresponding specific gravities, we shall have 100 opposite to c, 200 opposite to e, and 400 opposite to f. If we make intermediate divisions, each expressing an increase of specific gravity equal to $\frac{1}{100}$ part of the specific gravity of water, there will be 100 such divisions between c and e, and 200 between e and f. The space e f is however one-half of c e, so that the mean length of a division between c and e must be 4 times greater than that of a division between e and f. By making the same calculation for any portion of the stem, we may see that the decrease of the length of the divisions is gradual from c to f. A scale of this kind is called *uneven*.

We may, on the other hand, starting from the point c, divide the space c B into a certain number of equal parts. A scale of this kind is called *even*, and I may remind you that the greatest portion of the areometers used in the arts have even scales.

We are naturally led to inquire whether any relation exists between even scales and scales expressing specific gravities. I have seen it clearly stated in books that no such relation exists, and that the correspondencies of these divisions are found by means of tables, which, it must be inferred, were obtained experimentally, or by means of empirical formulas.

I believe that Francœur was the first mathematician who studied the relations between these two classes of scales, and he has left us two formulas, one for Beaumé's areometer for liquids heavier than water:

$$P = \frac{152}{152 - d}$$

and the other for Beaumé's instrument for liquids lighter than water:

$$P = \frac{146}{136+d}$$

In these formulas P represents the specific gravity, while d is the corresponding degree of an even scale.

We shall have occasion to return to these formulas, after we have studied the general relation which exists between the divisions of even scales, and their corresponding specific gravities.

To discover this relation, let us suppose that we have placed our cylindrical areometer in a liquid of specific gravity P, and that it has sunk to a point g of the stem. As the weight of liquid which buoys up an areometer must be equal to the weight of the areometer itself, the volumes of liquid displaced are inversely as their specific gravities. Now if we divide the space c B into a certain number, N, of equal parts, and if we find a number d of these divisions between c and g, the distance c B, which is the portion submerged in pure water will be expressed by N divisions or degrees, while the space g B, the portion submerged in a liquid of specific gravity P, will be N—d, and we shall have the equation:

$$\frac{P}{1} = \frac{N}{N-d}$$

from which, knowing d, we may calculate the value:

$$N = \frac{Pd}{P-1} \quad (1)$$

From this equation we may find the whole number of degrees of even scale from c downwards. This number N is obtained by multiplying the specific gravity by the corresponding number of degrees, and dividing this product by the difference between the same specific gravity and unity.

If we know the value of N for any scale, we may, inversely, calculate the value of d when P is known, or the value of P when d is known, by these formulas:

$$P = \frac{N}{N-d} \quad (2)$$

$$d = N - \frac{N}{P} \quad (3)$$

In Beaumé's original areometer for liquids heavier than water, 15° corresponded to sp. gr. 1.109. Formula (1) will give us, in this case,

$$N = \frac{1.109 \times 15}{0.109} = \frac{16635}{109} = 152.6$$

If we neglect 0.6, formula (2) will give us

$$P = \frac{152}{152 - d}$$

as given by Francœur.

Although this formula was correct for the original *pèse sel* of Beaumé, it does not answer for the instrument now sold as Beaumé's areometer, in which 66° correspond to the point to which the instrument sinks in sulphuric acid, $H^2 So^4$. Taking 1.845 for the specific gravity of $H^2 So^4$, we have by formula (1)

$$N = \frac{1.845 \times 66}{0.845} = \frac{121770}{845} = 144.02, \text{ or } 144$$

As Beaumé's areometer is extensively used in the arts, many chemical, technological and pharmaceutical books give tables for the conversion of its indications into corresponding specific gravities. In these tables, N is sometimes 152, sometimes 144, and at other times 145, 145.4, &c. It is a matter of some importance to determine the value of N in any table. Fortunately this may be done at a glance by observing the degree Beaumé which is equal to the fractional part of the number expressing the corresponding specific gravity. The quantity N is that specific gravity multiplied by 100. If we find in a table that 52° B=1.52 sp. gr., then N=152; for if in the equation

$$P = \frac{152}{152 - d}$$

we make d equal to 52, P will be 1.52, and if in the equation

$$P = \frac{144}{144 - d}$$

we make d=44, P will be 1.44.

It is very easy to do for other areometers what we have done for Beaumé's *pèse sel*. Let us take, in the next place, Beaumé's areometer for liquids lighter than water, which is extensively used in this country for petroleum products of all kinds. Beaumé obtained the scale of this instrument by calling 0 the point of the stem to which the areometer sinks in a solution of 10 parts of salt in 90 parts of water, and 10° the point to which it sinks in water. The instrument is graduated from 10° upward.

To find the value of N, let us temporarily call 0 the point to which it sinks in pure water, and 10° the point to which it sinks in a solution containing 10 p. c. of salt, whose specific gravity is 1.07353. By formula (1) we have:

$$N = \frac{1.07353 \times 10}{0.07353} = \frac{1073530}{7353} = 145.99$$

or 146. As in this instrument, the total number of degrees below 0

inches. In the lactometer of the Board of Health, 100° occupy $3\frac{1}{4}$, or 3.625 inches; then the whole number of degrees, 3548, would occupy

$$\frac{3.625 \times 3548}{100} = 128.61 \text{ inches} = 10 \text{ feet } 8.61 \text{ inches.}$$

In the areometer which I use for testing sugar solutions, 6° Balling, divided into tenths, occupy $2\frac{1}{2}$ inches, so the whole number of degrees = 260 must occupy

$$2.5 \times \frac{260}{6} = 111\tfrac{2}{3} \text{ inches} = 9 \text{ feet } 3.6 \text{ inches.}$$

To find the total length of a specific gravity areometer, we may calculate the number of degrees of an even scale which correspond to two points placed a known distance apart, and thence find the length corresponding to the whole number of degrees. Geisler's areometer for Ventzke's sugar test, studied in this way, gives a whole length of 200 inches, or $16\frac{2}{3}$ feet.

We have seen that if we know the specific gravity of a liquid, we may deduct the corresponding degree of any even scale, and *vice versa*. These relations afford us a sure method of verifying the correctness of the graduation of any areometer of even scale, by determining with the balance the specific gravity of a liquid, and comparing the corresponding division of even scale with the indication of the areometer under observation.

We may also convert the indications of any areometer of even scale into corresponding degrees of any other even scale. This is done by dividing the number of degrees to be converted by the total number of divisions of its kind, and multiplying this quotient by the total number of divisions of the kind we require. If we wish to know, for instance, what degree Beaumé is equivalent to 100° of the lactometer of the Board of Health, we will find that

$$\frac{100 \times 144}{3518} = 4°.058 \text{ Beaumé.}$$

Areometers of even scale have this precious property, that, provided the divisions are equal to one another, and the caliber of the stem is even, we may obtain accurate results by their use, even if the divisions have not the proper length, and if the point corresponding to pure water has been misplaced. By determining the specific gravity corresponding to two points of an even scale under observation, we may correct any indication of such a scale. In *American Chemist* for October, 1873 (vol IV, p. 130), and in *Sugar Cane* for January, 1874 (vol. VI, p. 28), these calculations may be found at full length.*

* On reading over the corrections for areometers of even scale, in *American Chemist* for November, 1873, I find that the subject may be presented in a more satisfactory manner, and more in harmony with the results of this paper, as follows:

In conclusion of this first part, I will examine a point which was introduced at our last meeting. We were told that if we refer the

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To ascertain the correctness of an areometer of even scale, we find by compasses and callipers that the divisions are equal to each other, and that the caliber is even —otherwise the instrument is not fit for accurate work. If these two points are satisfactory, we make two solutions, A and B, of different densities, B being the more dense. A must correspond to one end of the scale, and B to the other, but both must be within the scale. The temperature of the solutions should not be very different from that of the room, so as to remain constant for some time. The areometer to be examined should be placed successively in each solution; let us call the two indications a and b. In the next place, the specific gravity should be taken by the balance, which we will call P for A, and P′ for B. The degrees corresponding to P and P′ are calculated in the case of the total number of degrees N, and we obtain:

$$c = N - \frac{N}{P}$$

$$e = N - \frac{N}{P'}$$

If $a = c$ and $b = e$, the areometer is properly graduated.

If a is not equal to c, and b is not equal to e, but still $b - a = e - c$, the divisions of the scale are correct, but have been misplaced, the misplacement $m = c - a = e - b$, m being positive or negative, and it has to be either added to or subtracted from the degree of the areometer to effect the correction.

Again, a may be greater or smaller than c, and b greater or smaller than e, and at the same time $b - a$ is not equal to $e - c$. In this case the degrees themselves have not the proper length, and we are led to ask what is N′, the total number of degrees of the areometer under examination? If we call n' the number of degrees between c and e, and n the number between a and b, we have the relation

$$\frac{N'}{N} = \frac{n'}{n}$$

whence

$$N' = \frac{n' N}{n}$$

When the degrees of the scale have not the proper length, two cases may occur— 1° The 0° (pure water, normal temperature) is in the right place. 2° The 0° has been misplaced. If

$$\frac{a}{c} = \frac{b}{e} = \frac{N'}{N}$$

the zero is in its place; and if we call d' any degree of the areometer under examination, the correct degree,

$$d = \frac{d' \times N}{N'}$$

If the 0 of the scale has been misplaced, the relation

$$\frac{a}{c} = \frac{b}{e} = \frac{N'}{N}$$

does not exist. To discover the amount of displacement, we must take either of the specific gravities P or P′, and determine the true degree corresponding to either a or b, on the base of N′ being the total number of degrees. If we take a and sp. gr. P, the true degree

$$x = N' - \frac{N'}{P}$$

The quantity $x - a$ shows the displacement m, which is positive if $x > a$, or negative if $a > x$, and the true degree

$$d = \frac{N}{N'} (d' \pm m)$$

divisions of an areometer of even scale, and the corresponding specific gravities — 1 to rectangular co-ordinates, the law of their relations is expressed by a right line. To those who remember their analytical geometry it is easy to show that this is not the case, for if we take the equation

$$\frac{Pd}{P-1} = N,$$

which we have had to use repeatedly, and in which are comprised the quantities d and P—1, and if we multiply both terms by P—1 and divide them by P, we shall have

$$d = (P-1)\frac{N}{P}$$

Now the equation of the right line is of the form $d=m(P-1)$, in which m is a constant, while $\frac{N}{P}$ cannot be a constant as P is variable,

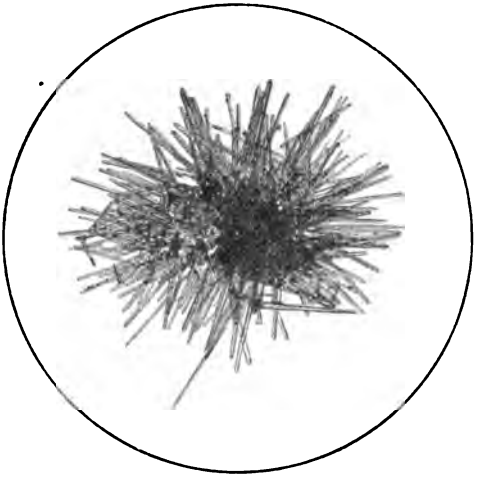
therefore $$d = (P-1)\frac{N}{P}$$

cannot give a right line.

By actually referring d and P—1 to perpendicular co-ordinates, we find that the law is expressed by a curve, which does not differ materially from an arc of a circle, which curve turns its concavity towards the abscisses. The greatest deviation from a right line takes place about midway between the two extremes. This may be illustrated by taking Beaumé's areometer from 0 to 50°, in which 0° corresponds to P—1=0, and 50° to P—1=0.532. If the law was a right line, we would have the numbers of the second column, while the actual numbers are those in the third column.

Degrees Beaumé.	$m = \frac{P-1}{a} = \frac{0.532}{50}$ $m = 0.01064$	$P-1 = d\frac{N}{P}$	Difference.
10°	0.1064 (14°)	0.0746	0.0318
20°	0.2128 (25°)	0.1613	0.0515
25°	0.2666 (30°)	0 2101	0.0565
30°	0.3192 (35°)	0.2632	0.0560
40°	0.4256 (43°)	0.3846	0.0410

After the values of P—1, in the second column, I have placed between brackets the nearest whole number of degrees to which they correspond.



Magnified 100 Diameters.

HYPOXANTHINE SILVER NITRATE.

From a Microphotograph by M. N. MILLER, M. D.

LI.—On the Production of Magnesium Nitride by Smothered Combustion of Magnesium in Air.

By J. W. MALLET.

The existence of a nitride of magnesium was first noticed by Deville and Caron,* in connection with the purification of the metal by distillation.

Brieglich and Genther† afterwards obtained this compound by passing ammonia or nitrogen over strongly heated magnesium. The amorphous mass produced, of greenish-yellow color, had approximately the composition Mg_3N_2. I have lately observed the formation of the same substance in large quantity in the simple combustion of magnesium with limited access of air.

Using the burning of a piece of magnesium ribbon, as it so often has been used, to illustrate to students the fact that the metal gains in weight by oxidation, I held the coiled-up ribbon pretty well down in a porcelain crucible to diminish the loss of magnesia in fume carried up by the heated air, and finally dropped a part of the metal, still burning, into the bottom of the crucible.

Washing the vessel out afterwards, I noticed that water at once produced effervescence and a distinct smell of ammonia.

On repeating the experiment with a larger piece of the ribbon, placed at once at the bottom of the crucible, the same result was obtained, and with far greater distinctness when magnesium filings were used, the residue in this latter case having a well marked greenish-yellow color, and giving off abundance of ammonia on addition of water or a solution of a caustic alkali. When but a few drops of liquid are added, the heat evolved is so great as sometimes to ignite a portion of the mass, and much of the powder is scattered by the escaping ammonia and vapor of water.

The porcelain being attacked, and a dark brown film of silicon formed upon it, I wished to ascertain whether this element had anything to do with the absorption of the atmospheric nitrogen, and therefore substituted an iron crucible, but without changing the result. The magnesium used was itself examined, and found free from silicon.

The chief part of the metal burned is, of course, converted into oxide, with the production of a temperature high enough to induce the remainder, when the supply of oxygen is limited, to unite with nitrogen. The amount of nitride formed, varies with the manner in which the combustion is managed. I have found the best result to be obtained when the crucible, of usual Berlin porcelain shape, is filled to about one-

* Comptes rendus, xliv, 394.

† Ann. d. Chem. u. Pharm., cxxiii, 228.

third its depth with the filings, and heated gently over a lamp, the filings ignited at the top by a red-hot iron wire, and from time to time, but not continuously, gently stirred with the wire. A peculiar orange glow, unlike the brilliant light of the magnesium burning with free supply of air, and a slight apparent clotting together of the filings, indicate the formation of the nitride.

To determine approximately how far nitrogen may thus be taken up, I in several instances weighed the metal, and, cooling the crucible rapidly by standing it upon an iron block, transferred its contents to a small flask, in which was a test-tube of water or a solution of potassium hydrate. Attaching a set of absorption bulbs with a measured volume of normal sulphuric acid, I very gradually tilted the flask so as to bring the alkaline liquid in contact with the powder, and, after action in the cold was over, heated to the boiling point, and drew air through the apparatus with an aspirator. The unsaturated acid in the bulbs was determined with a normal alkaline solution.

The three experiments showing the largest absorption of nitrogen, gave the following results. A little magnesium was lost in the fumes, but that, doubtless, altogether in the form of oxide:

	Mg. used.	NH_3 obtained.	Equiv. Mg_3N_2	Equiv. Mg.	Mg. converted into nitride, pr. 100 pts. Mg. used
No. 1	2.635 grns.	0.292 grns.	0.859 grns.	0.618 grns.	23.5
No. 2	2.204 "	0.286 "	0.841 "	0.606 "	27.5
No. 3	3.117 "	0.365 "	1.074 "	0.773 "	24.8

This mode of treating magnesium furnishes a simple and effective lecture-table illustration of the formation of a metallic nitride, and of some of the reactions presented by bodies of this class.

University of Virginia, April, 1877.

LII.—Proceedings.

Regular Meeting, Thursday, May 3d, 1877.

The meeting was called to order at 8:15 P. M. Vice-President Chandler in the chair. The minutes of the last meeting were read and approved.

The following were elected:

As members—Thos. Norton, Berlin, Germany; A. Penissat, Clermont Ferrand, France; Jos. C. F. Cheever, N. Y.; J. H. Appleton, Providence, R. I.; Chas. Edgar Dwight, Wheeling, W. Va.; T. O'C. Sloan, N. Y.

As associates—Francis Forbes, N. Y.; A. P. Howard, Boston, Mass.; O. B. Stillman, Boston, Mass.; Edward S. Renwick, N. Y.

The following were proposed:

As members—W. H. Gregg, Elmira, N. Y.; Edgar F. Smith, Philadelphia.

As associate—General John Newton, N. Y.

The following papers were read:

1. On Areometers. Part II. By P. Casamajor.

2. On the Abnormal Constituents of Blood in Leucocythemia. By Dr. Chas. A. Doremus.

3. On certain Flame Reactions of Silver. By Prof. M. B. Hardin.

4. On Areometers. Areometer of Resumé for Liquids heavier than Water. (1) By A. Bourgougnon.

Adjourned.

LIII.—On Areometers. Part II.

Correction of the Indications of Areometers for errors resulting from variations of temperature.

By P. CASAMAJOR.

The methods that I propose to give for the correction of the indications of areometers, when observations are made at temperatures differing from the normal, are applicable to all liquids, but, as I am not in possession of accurate data relating to the expansion of other liquids than pure water and sugar solutions, I shall confine myself to these. The application to any other liquid, however, is equally easy, if we possess sufficient data on its expansion by heat.

I propose to consider temperatures from 5° to 45° C. only, as these limits need never be exceeded in our laboratories.

At our December meeting, I gave the following table, of which the first column contains the degrees Centigrade from 5° to 45°; the numbers of the second column represent the total *absolute* contractions and expansions of 1 C. C. of water at every degree of temperature, starting from 15° C. as a normal, and the numbers of the third column represent the total *relative* expansions and contractions for the same temperatures. These last numbers were obtained by subtracting 0.000026, the cubic expansion of glass, as many times from the corresponding numbers of the second column, as there are units *minus* 15, in the number expressing the degree Centigrade. The numbers in this third column represent the visible expansion of water in glass vessels.

TABLE No. 1.—TOTAL EXPANSION FROM 15° C.

Degree C.	Absolute Expansion.	Relative Expansion.	Degree C.	Absolute Expansion.	Relative Expansion.
5°	0.000878	0.000612	25°	0.002179	0.001919
6°	0.000856	0.000622	26°	0.002445	0.002159
7°	0.000820	0.000612	27°	0.002717	0.002405
8°	0.000772	0.000590	28°	0.002995	0.002657
9°	0.000706	0.000550	29°	0.003279	0.002913
10°	0.000622	0.000492	30°	0.003569	0.003179
11°	0 000524	0.000420	31°	0.003869	0.003453
12°	0.000412	0.000334	32°	0.004181	0.003739
13°	0.000288	0.000236	33°	0.004503	0.004035
14°	0.000150	0.000124	34°	0.004836	0.004342
15°	Normal.	Normal.	35°	0.005180	0.004660
16°	0.000173	0.000147	36°	0.005533	0.004987
17°	0.000357	0.000305	37°	0.005895	0.005323
18°	0.000551	0.000473	38°	0.006265	0.005667
19°	0.000756	0.000652	39°	0.006644	0.006040
20°	0.000971	0.000841	40°	0.007032	0.006382
21°	0.001119	0.001039	41°	0.007428	0.006752
22°	0.001428	0.001246	42°	0.007832	0.007130
23°	0.001670	0.001462	43°	0.008244	0.007516
24°	0.001920	0.001686	44°	0.008664	0.007910
			45°	0.009092	0.008312

Referring again to the paper read before this Society in December, I will recall to your memory that by drawing a series of parallel equidistant lines, intersected by another series of similar lines perpendicular to the first; by making the space between two vertical lines equivalent to 1° Centigrade, and the space between two horizontal lines equivalent to 0.0001 C.C., we were able to simplify the work of correcting the errors due to changes of temperature. We took on every vertical line a distance equivalent to the relative expansion corresponding to the temperature represented by that line, and we connected all the points thus obtained by a curve. Afterwards, by noting the points at which the curve intersects the horizontal lines representing 0.0005, 0.001, 0.0015, 0.002, 0,0025, &c., we were able to find the temperatures corresponding to these expansions as follows:

TABLE No. 2.

—0.0005	corresponds	to	9°.9	Centigrade.
0.	"	"	15°	"
0.0005	"	"	18°.2	"
0.001	"	"	20°.75	"
0.0015	"	"	23°.2	"
0.002	"	"	25°.3	"
0.0025	"	"	27°.3	"
0.003	"	"	29°.4	"
0.0035	"	"	31°.2	"
0.004	"	"	32°.8	"
0.0045	"	"	34°.5	"
0.005	"	"	36°.1	"
0.0055	"	"	37°.6	"
0.006	"	"	38°.8	"
0.0065	"	"	40°.4	"
0.007	"	"	41°.6	"
0.0075	"	"	42°.9	"
0.008	"	"	44°.2	"
0.0083	"	"	45°	"

To enable us to make use of the data contained in Tables No. 1 and No. 2, let us examine what happens with an areometer floating in a liquid, when the density of the liquid varies on account of a change of temperature.

If we suppose that the temperature increases, the liquid will expand, and the areometer also, but everything will take place as if the volume of the areometer remained constant, and the expansion of the liquid was equal to the relative expansion of water in glass.

If we have an areometer which indicates specific gravities, and if we place it in pure water, at the normal temperature, 15° C., the instrument will sink to a point marked 1. If the temperature increases, the specific gravity of the liquid diminishes and the areometer sinks deeper in the liquid. If, for instance, the temperature of the water is 35° C., we will find in the third column of Table No. 1 that at 35° 1 C.C. becomes 1.00466, consequently at 35°, the specific gravity of water is $\frac{1}{1.00466} = 0.9953$. As, before we have done with this subject, we shall have to correct the errors due to variations of temperature in the case of pure water, please to observe that, if the temperature is 35° C., and the indication of the areometer 0.9953, we will obtain the true specific gravity by multiplying 0.9953 by 1,00466.

I may also call to your attention that the correction may be more easily made by simply adding 0.00466 to 0 9953, which gives 0.99996, which is very approximately equal to 1.

If we wish to make use of Table No. 2, let us suppose that the temperature is 20°.75, at which 1 C.C. becomes 1.001 C.C. The specific gravity will then be $\frac{1}{1.001}=0.99908$ (very approximately 0.999). In this case we may rectify this indication of the areometer by multiplying it by 1.001. Please to notice, however, that the correction is, as above, more easily obtained by adding to 0.999 the number 0.001 placed opposite to 20°.75 (0.999+0.001=1).

In the same way, if the temperature is 44°.2 C., we find, opposite to it, the expansion 0.008, and the specific gravity of water becomes $\frac{1}{1.008}=0.99206$, very approximately 0.992. We may notice, again, that the correction is easily made by adding to 0.992, the expansion 0.008 placed opposite 44.2 C.

We may then make use of Table No. 2 by simply adding the numbers opposite to the temperatures observed, to obtain the correct reading at 15° C., in the case of pure water.

In the table marked No. 2 we have not, as in Table No. 1, every degree of the scale, but as the expansions corresponding to the temperatures in that table only differ by a quantity equal to 0.0005 C.C., no appreciable error is committed by taking the temperature in the table which comes nearest to the temperature observed.

Let us now take the case of an areometer with an even scale, and examine what happens when the liquid in which it floats is submitted to a change of temperature. If we had an areometer which would sink in pure water at 15° C., so that the liquid displaced was equal to 1 C.C., when the temperature of the water increased, it would sink deeper, the extra volume of liquid displaced being equal to the relative expansion at the temperature observed, as shown in the third column of Table No. 1. If the volume of water displaced at 15° was 2 C.C., the increased volume of water to buoy up the areometer would be, for any temperature, the relative expansion of 1 C.C. at that temperature multiplied by 2. In more general terms, if the volume of water displaced at 15° C. was N cubic centimeters, the additional volume at any temperature would be the relative expansion, at that temperature, multiplied by N.

We have seen, however, that the divisions of an even scale are only equal volumes into which the total volume of the areometer is divided. Therefore, if we have an areometer with a total number of degrees, N, we may obtain the correction in degrees at any temperature by multiplying the total relative expansion at that temperature (Table No. 1, third column) by N, the total number of degrees.

In the preceding remarks, I have always supposed that the temperature observed was above 15° C. If the temperature is below 15°, a contraction takes place, which is to be subtracted.

We may now proceed to apply the principle I have established to the correction of errors due to changes of temperature in the case of sugar solutions.

In a paper, *On the Expansion of Sugar Solutions by Heat*, published in *American Chemist* for June, 1874 (vol. IV. p. 447), I gave a detailed account of the researches I was obliged to make to ascertain the expansion of sugar solutions up to the solution containing 23 p. c. of sugar. As my object was limited to solutions which can be introduced directly in the tube of the saccharometer, I did not, at that time, go beyond 23 p. c. of sugar. The extreme temperatures were 5° and 45° Centigrade. I took a certain volume of liquid at 5°, and ascertained the total expansion from 5° to 45°, and afterwards divided this expansion by 40, the total number of degrees, and by the volume at 5° in cubic centimeters, the result being the mean expansion of 1 C.C. for every degree between these limits of temperature. The expansion of pure water was ascertained in this way, also that of sugar solutions containing $11\frac{1}{2}$ p. c. and 23 p. c. of sugar.

The mean relative expansion of 1 C.C. of water for every degree Centigrade between 5° and 45° was found to be 0.00021 ; * that of the solution containing 23 p. c. of sugar was 0.00023, and the solution containing $11\frac{1}{2}$ p. c., instead of giving the average 0.00022, gave repeatedly 0.000215. As this latter number did not depart very sensibly from the average, I had a right to conclude that the intermediate numbers followed materially the same laws as the extremes.

To apply the expansion 0.00021 to the areometer which I use for testing sugar solutions, we must remember that we found for this areometer $N=260$; therefore the average expansion for an increase of 1° C. is $260\times0.00021=0.0546$ degree.

If we place the same areometer in a solution 23° Balling, the submerged portion is $260°-23°=237$ degrees Balling, and the average expansion in this case is $237\times0.00023=0.0545$. As we have admitted that the intermediate solutions follow materially the same laws as the extremes, we arrive at this remarkable result: that *the mean correction for variation of temperature is the same for sugar solutions up to* 23 *p. c. of sugar as for water.* Now, if we remember that the graduation of a Balling areometer increases downward, so that the deeper the instru-

* For the sake of comparison we may add the total relative expansion from 15° to 45° (0.008312) to the total relative contraction from 15° to 5° (0.000612), as found in the third column of Table No. 1, and divide the sum, 0.008924, by 40, which gives 0.000223. This number is very nearly the same as the one I found directly. If we consider the series of operations by which the numbers 0.008312 and 0.000612 were obtained, as explained in the paper read before this Society in December, the coincidence, or *quasi* coincidence, is certainly satisfactory.

ment sinks the less is the degree indicated; and if we admit that the expansion from degree to degree is 0°.0545, we may see that the indication at any temperature may be restored to that corresponding to the normal by adding 0.0545 as many times to the observed indication as there are degrees between the observed temperature and the normal.

If 15° is the normal, at 16° we would have to add 0°.0545, at 17° 0°.109, at 18° 0°.163, &c. Between 12° and 27° C., to which I always brought the temperature of my solutions, the error committed by taking a uniform expansion does not exceed 0°.087.

I have, however, more recently calculated the expansion of water for every degree C. Taking 15° C. as a normal, the numbers of the following table, No. 3, were obtained by multiplying the relative expansions as given in the third column of Table No. 1 by 260. Table No. 4 is calculated by taking 17½° C. as a normal, to be used for areometers made in Germany, as these are based on 17½ C. (14° R.)

TABLE No. 3.—CORRECTIONS OF BALLING'S AREOMETER.
(Normal Temperature 15° C.)

Degree Centigrade.	Correction of the Areometer.	Degree Centigrade.	Correction of the Areometer.	Degree Centigrade.	Correction of the Areometer.
5°	0.159	19°	0.169	33°	1.049
6°	0.161	20°	0.218	34°	1.128
7°	0.159	21°	0.269	35°	1.212
8°	0.153	22°	0 323	36°	1.297
9°	0.143	23°	0.380	37°	1.384
10°	0.127	24°	0.438	38°	1.473
11°	0.109	25°	0.506	39°	1.570
12°	0.086	26°	0.567	40°	1.659
13°	0.062	27°	0.631	41°	1.755
14°	0.032	28°	0.697	42°	1.854
15°	Normal.	29°	0.764	43°	1.954
16°	0.038	30°	0.833	44°	2.054
17°	0.079	31°	0.898	45°	2.158
18°	0.123	32°	0.972		

TABLE No. 4.—CORRECTIONS OF BALLING'S AREOMETER.
(Normal Temperature 17½° C.)

Degree Centigrade.	Correction of Areometer.	Degree Centigrade.	Correction of Areometer.	Degree Centigrade.	Correction of Areometer.
5½°	0.262	19½°	0 083	33½°	0.983
6½°	0.263	20½°	0.143	34½°	1.037
7½°	0.261	21½°	0.193	35½°	1.120
8½°	0.252	22½°	0 250	36½°	1 204
9½°	0.243	23½°	0.308	37½°	1.344
10½°	0.228	24½°	0.367	38½°	1 381
11½°	0.208	25½°	0.428	39½°	1.473
12½°	0.183	26½°	0.492	40½°	1.573
13½°	0.157	27½°	0.557	41½°	1.664
14½°	0.110	28½°	0.622	42½°	1.762
15½°	0.076	29½°	0.700	43½°	1.862
16½°	0.040	30½°	0.765	44½°	1.964
17½°	Normal.	31½°	0.832	45½°	2.079
18½°	0.045	32½°	0.907		

To make use of either of these tables, we place a Balling's areometer in a sugar solution, and note the degree and tenth of degree indicated, and afterwards place in the same solution a thermometer, and note the temperature. Opposite to the temperature observed, we find the number to be added to the indication of the areometer, if above the normal, or to be subtracted, if below.

If we take 15° C. as a normal, and the areometer gives 12°.8, while the thermometer shows 20°, the correction in Table No. 3 is 0.218, which is added to 12.8, giving 13.018.

We may, however, correct the indication of the Balling areometer in a simpler and quicker way by using a method entirely analogous to that which I gave for volumetric analysis in the paper read before this Society in December.

This consists in erecting a series of vertical equidistant lines, the space between two of which corresponds to 1° C., and intersecting these lines by a series of equidistant lines perpendicular to the first, the distances between two of which we may make equivalent to 0°.01 Balling. We may then, adopting either 15° or 17½° C. as a normal, take on every vertical line a distance corresponding to the hundredths of a degree, as found in the second column of Table No. 3 or No. 4, and afterwards connect the points thus obtained by a curve. By finding the points at which this curve intersects the horizontal lines cor-

responding to 0.1, 0.2, &c., of a degree, and noting the temperatures at these intersections, we form Table No. 5 for 15° C. as a normal, and Table No. 6 for 17½° C. as normal. We may notice that, in Table No. 5, the correction +0°.1 happens at 17½° C., so that Table No. 6 is easily obtained by subtracting 0.1 from the indications of the preceding table.

TABLE No. 5.

Degree Centigrade.	Degree Balling to be added.
9°.5	—0.15
11°.8	—0.1
15°.	Normal.
17°.5	0.1
19°.7	0.2
21°.6	0.3
23°.4	0.4
25°.2	0.5
26°.7	0.6
28°.2	0.7
29°.5	0.8
31°.	0.9
32°.5	1.
34°.	1.1
35°.	1.2
36°.4	1.3
37°.7	1.4
38°.8	1.5
40°.	1.6
40°.7	1.7
41°.8	1.8
43°.	1.9
44°.	2.
45°.	2.1

TABLE No. 6.

Degree Centigrade.	Degree Balling to be added.
9°.5	—0.25
11°.8	—0.2
15°.	—0.1
17°.5	Normal.
19°.7	0.1
21°.6	0.2
23°.4	0.3
25°.2	0.4
26°.7	0.5
28°.2	0.6
29°.5	0.7
31°.	0.8
32°.5	0.9
34°.	1.
35°.	1.1
36°.4	1.2
37°.7	1.3
38°.8	1.4
40°.	1.5
40°.7	1.6
41°.8	1.7
43°.	1.8
44°.	1.9
45°.	2.

We may, instead of either of these tables, use a thermometer with an ivory scale, having, on one side of the mercury column, the degrees C., and, on the other side, the numbers in the second column of either Table No. 5 or Table No. 6, exactly as for the thermometer which I described in detail in the paper read before this Society in December.

If, instead of the areometer giving the percentage of sugar, we wish to use one giving the specific gravities, we must remember that, in the case of water, we may use Table No. 2 by simply adding the numbers opposite to the temperatures observed to obtain the correct reading at

the normal temperature. We have shown, besides, that for Balling's areometer *the correction of temperature is the same for all sugar solutions up to* 23 *p. c. of sugar as for water.* Therefore for any sugar solution, up to sp. gr. 1.1, we have merely to add the numbers opposite to the temperatures observed, as found in Table No. 2, to restore the indication of the areometer to the specific gravity at 15° C.

If, as it is usual in Germany, we take 17½° C. as a normal, we may use the following table, No. 7.

TABLE No. 7.

Degree Centigrade.	Quantity to add to sp. gr.	Degree Centigrade.	Quantity to add to sp. gr.
7°.5	—0.001	34°.7	0.004
13°.	—0.0005	36°.2	0.0045
17°.5	0.	37°.4	0.005
20°.2	0.0005	39°.	0.0055
23°.	0.001	40°.5	0.006
25°.	0.0015	42°.	0.0065
27°.	0.002	43°.4	0.007
29°.	0.0025	44°.2	0.0075
31°.	0 003	45°.	0.008
32°.5	0.0035		

As in previous cases, we may, instead of using the Tables No. 2 and No. 7, write the corrections directly on the ivory scale of a thermometer on one side of the column of mercury, opposite to the corresponding temperatures on the other side.

In describing the methods that I have given for correcting the errors in the indications of areometers in the case of sugar solutions up to the solution holding 23 p. c. of sugar, I have proved that the total correction for expansion is the same as for pure water from 5° to 45° C., but I have not afforded any proof that sugar solutions vary in expansion from degree to degree in a manner exactly parallel to the expansion of water, although I have assumed that such is the case. I can say, however, that I have the best of reasons for knowing that no appreciable error is committed by this assumption, for, by making a great number of tests of the same sugar at different temperatures and at different degrees of dilution, I have repeatedly obtained the same coefficient of purity within less than ½ p. c. As such facts have presented themselves hundreds of times in my practice, I have no hesitation in recommending the method I have given for solutions within the limits mentioned.

This conclusion is confirmed by what happens when a solution containing $11\frac{1}{2}$ p. c. or 23 p. c. of sugar is placed in a dilatometer and cooled down to 5° C., and afterwards the dilatometer is placed in a water bath kept at 45° C. The volume of the solution increases at first very slowly, but gradually the rate of increase, for equal spaces of time, becomes greater, and, towards the end, the increase of volume is very rapid. As the rate at which the temperature of the solution increases is proportional to the excess of the temperature of the bath over that of the contents of the dilatometer, the rate of increase of temperature is greater at first than towards the end. This circumstance renders the increase of the rate of expansion towards the end more remarkable, and shows that the law of expansion for these sugar solutions is very nearly the same as for water.

As to thicker sugar solutions, I have lately determined the expansion of the solution of specific gravity 1.192 (23°.2 Beaumé), and that of the solution of specific gravity 1.3116 (34°.2 Beaumé), between 5° and 45° C., which are given in the table below. To compare the corrections to be made with areometers of even scales, in the case of these expansions, with the corrections in the case of solutions containing 23 p. c. of sugar or less, I have expressed the densities of all these solutions in Beaumé degrees, as Beaumé's areometer, in which N=144 is commonly used for sugar solutions of all kinds, while the areometer in which N=260 is only suitable for weak solutions, as I have already explained.*

Degree Beaumé.	Average expansion of 1 C.C. between 5° and 45° C.	Number of areometer degrees submerged.	Correction— Product of 2d by 3d column.
0°	0.00021	144	0.03024
13° (23% Sugar).	0.00023	131	0.03013
23°.2	$0.00028\frac{1}{4}$	120.8	0.03473
34°.2	0.000328	109.8	0.03601

We may see in this table that at 0 and 13° Beaumé the correction is materially the same as I have shown for the areometer in which N=260.

In the case of thicker solutions, up to 34° Beaumé, we may also see that the corrections are represented by larger numbers, and we are naturally led to inquire whether for such solutions we may still correct

* Part first.

the indications of areometers by using the tables I have given this evening without incurring the risk of committing serious errors.

As the error committed would be the greatest with a solution of 34°.2 Beaumé, we may find the maximum error by calculating on the base of a mean correction for every degree Centigrade=0°.03601, and supposing that the observation is taken at 45° C. The total correction in this case is 0°.03601 × 30=1°.083, while, if the mean correction for every degree C. is 0°.0302, the total correction is 0.0302 × 30=.906; the difference, 0.177, is the maximum error we may commit by using the table I have given. For thinner solutions and for lower temperatures the error would be less.

In the case of sugar solutions having 23 p. c. of sugar or less, I have given my reasons for thinking that their laws of expansion are similar to those of pure water. I may add that solutions of density equal to 23°.2 Beaumé and 34°.2 Beaumé show the same peculiarity in the dilatometer of greater expansion for equal spaces of time as the temperature increases.

LIV.—Abnormal Constituents of the Blood due to Leucocythemia.

By C. A. DOREMUS, Ph. D.

About a year ago Prof. E. G. Janeway called my attention to the facts regarding the presence of hypoxanthine in the urine of persons suffering from splenic leucocythemia; and requested me to examine a sample of urine. The urine was subjected to analysis, but from the small quantity at my disposal I was unable to get the reactions of hypoxanthine. Neubauer and Vogel * recommend the employment of from 40 to 50 litres for the detection of xanthine (normally present in the urine), and Salkowski † advises 10 to 15 litres of abnormal urine as necessary for an investigation.

Shortly after this, Prof. Janeway gave me a sample of blood taken from the vena cava descendens of a man (æt. 21) less than 24 hours *post mortem*. The pathological history of the case is given in the *Medical Record*, Nos. 286 and 287 of 1876. The case was one of true splenic leucocythemia.

The blood, when I received it, was watery, its reaction slightly acid, sp. gr. at 62° F. 1.035, and measured 95 c.c. Its microscopic appearance was characteristic of the diseased condition. The ratio of the white to red corpuscles, was about 1:3 or 1:5. Prof. Janeway

* Neubauer and Vogel, *Harnanalyse*, 1876, p. 26.

† Salkowski, Virchow's Archiv, B. 50, p. 174. Although Salkowski worked with large quantities of urine, he found no hypoxanthine, but a body having some of its reactions.

estimated 1:4, and detected also various forms of white corpuscles. The spectroscopic examination showed the absorption bands of oxy-hæmoglobin, but nothing further. Analyses of leukhæmic blood by Scherer and Strecker show that the amount of iron is diminished about one-half, from 0.5321 pro mille (Pelouse) to 0.298 Scherer, or 0.342 Strecker.

In testing for abnormal chemical compounds, it was all important to select a method of analysis by means of which the different constituents could be accurately determined. Careful comparison of several authorities, supplemented by experiments, pointed to that of Dr. E. Salkowski * as the most reliable.

His researches on the presence of the various abnormal bodies, both in the urine and blood, made in 1870, were so carefully worked out and described that they commended themselves immediately as trustworthy. In making this investigation, I have found the details he gives corroborated at almost every step.

90 c.c. of the blood in question were diluted with hot water, and then brought to the boiling point on a water bath, and finally over a flame. A copious coagulate formed. This was separated by filtration and pressed. The filtrate was not quite clear, but remained slightly opalescent, and owing to the partial disintegration of the blood corpuscles from incipient decomposition before the analysis was begun, it was of a light brown color. This color may have been due in part to the incomplete or tardy coagulation; it would seem best therefore to bring the liquid speedily to a boil. The filtrate was evaporated, and the films that formed removed once or twice by filtration. A clear, light brown liquid was at last obtained, which was allowed to stand over strong sulphuric acid for several days. No crystals appeared except toward the last, when cross or dagger shaped crystals showed themselves on the top edge of the mass, for the liquid had solidified to such an extent that the dish could be inverted without its falling out.

Strong, nearly absolute, alcohol was then poured on in quantity. A precipitate formed at once; it was filtered off, washed with alcohol, then dried. The residue weighed 1.043 grains. It was moistened with cold water, more water was added, and the whole heated on the water bath, It dissolved with the exception of one or two flocculi. The solution was filtered and the filter washed. The liquor was of a clear brown color, and when evaporated over sulphuric acid left a residue of 0.7457 grains weight, or 0.8 per cent. of the blood.

This residue proved to be a body closely resembling, if not identical with glutin.

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* Opus cit.

It was insoluble in cold water and in alcohol, but was readily dissolved in warm water, and gelatinized on cooling. It gave no precipitate with potassium ferrocyanide in an acetic acid solution. Herein it differs from that found by Salkowski which gave a turbidity, and from that found by Gorup-Besanez,* which did precipitate with these reagents.

It was precipitated by mercuric chloride, and by tannic acid. With lead acetate it agreed with that found by both Salkowski and Gorup-Besanez in giving a copious white precipitate, and thus differing markedly from pure glutin. I made repeated attempts to get a determination of its action on polarized light, but the solution, even when just filtered, was so opalescent that the light would not traverse it. Dilution with water, or treatment by fixed alkali did not remedy the matter. I have reserved a part for further testing.

The filtrate from the precipitated glutin was nearly clear—on evaporation of the alcohol perfectly so—and of a light yellow color. On standing it deposited the same dagger shaped crystals as before, and afterwards cubes of chlorides, as determined by the crystalline form, flame reaction, and reaction with silver nitrate. Whether the potassium of the blood is replaced even in part by sodium I did not determine. To be sure of removing all glutin, this evaporated liquid was again treated with alcohol, boiled with it, filtered and set aside. Some time elapsed before its analysis was resumed.

A question now arose how to test for hypoxanthine, the body I was primarily in search of. In consequence of the many contradictory statements in the books, only one way was open to me, that of preparing some of the remarkable body, which was accomplished by following Neubauer's † method of obtaining it from Liebig's extract. This part of the work proved very tedious, owing to the length of time required to evaporate the solutions at low temperature, but I was rewarded by obtaining a goodly quantity of hypoxanthine and some xanthine. I was moreover made conversant, from these experiments, with the deportment of the substances I was in search of, and enabled to recognize them in small quantities. As Salkowski throws a doubt, in his memoir, on all previous determinations of hypoxanthine, I was anxious to satisfy myself thoroughly on the points wherein he differed from other investigators, but I might have spared myself the trouble as to this, since his statements were fully verified by the reactions obtained.

The solution, containing the suspected bodies, had not changed by the long standing, at least not outwardly. When diluted with water it

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* Journal Chem. Soc. 1874, p. 811.

† Zeitschrift für analytische Chemie, B. 6, 1867.

became slightly turbid, but yielded a clear filtrate. Ammonium hydrate was added, and then ammoniated silver nitrate. An abundant brown flocculent precipitate formed. This was filtered off, washed, and dissolved in boiling nitric acid 1.1 sp. gr. On cooling, the characteristic prismatic crystals of hypoxanthine silver nitrate were deposited. Some of these I show you as a microscopic specimen; and, through the kindness of Prof. J. W. S. Arnold, some microphotographs of them. The resemblance of the crystals obtained from the blood and those from Liebig's extract can be readily traced.

The crystals were redissolved in acid, and reprecipitated by ammonium hydrate as the flocculent mass first referred to. After suspension in water, this was decomposed by sulphureted hydrogen, and the liquid filtered from the silver sulphide evaporated to dryness. The microscope showed the presence of crystals of hypoxanthine nitrate. I have also a specimen of these, and a photograph. Placed on a porcelain cover and moistened with nitric acid, this nitrate became slightly yellow on heating, and on applying sodium hydrate, turned but a shade darker. The substance therefore was hypoxanthine, and was free from xanthine, uric acid and guanine. From the very small quantity remaining I was deterred from making further tests, especially as the most characteristic had resulted favorably.

The ammoniacal solution from which the hypoxanthine had first been precipitated was treated with sulphuric acid to strong acid reaction. Filtered from the precipitated silver chloride, it was distilled to half its volume. The distillate was evaporated to dryness with sodium carbonate, and the residue extracted with absolute alcohol. No formic acid was found, and yet I am not surprised, since the quantity of blood taken for analysis was so small. From the reaction with ferric chloride, I should say acetic acid was present in small quantities. The residue in the retort was shaken many times with ether, mixed with a little alcohol, the ether evaporated, and the acid residue diluted with water, boiled with zinc carbonate, and filtered. Crystals of zinc lactate were plainly seen on the solution cooling. They were separated from the liquid, dissolved in boiling water, and the zinc precipitated by sulphureted hydrogen, and the solution filtered and evaporated. The zinc had however remained in part, and instead of obtaining free lactic acid, very perfect crystals of zinc lactate separated on standing. The forms of the crystals can be seen from the specimen and its photographs.

In the course of the analysis, I sought for any uric acid that might be present with the hypoxanthine, but failed to find any.

It may appear to some that the description of the process of analysis is superfluous. From one standpoint such might, at first thought, seem to be the case, but in physiological chemistry, as yet,

there are few positive rules, and it seems to me that in giving an account of the deportment of the various solutions and precipitates, the results obtained can be more fairly criticised, and any errors I may have committed rectified, than if the simple conclusions only had been stated.

We are indebted to Scherer for the discovery of the near relationship of the abnormal constituents of the blood to the extractive matters obtained from the spleen. Since his analysis, others have been made, and up to the present I have been able to find the record of six.

The results may be summarized thus:

Substance.	*Number of times found.*	*Tested for.*
Glutin-like substance,	4	
Formic acid,	6	
Lactic acid,*	5	
Acetic acid,	2	4 times.
Propionic acid,	1 (?)	
Leucin,	2	
Tyrosin,	1	
Uric acid,	3	
Hypoxanthine,†	2	

The blood under consideration contained the glutin-like substance, lactic acid, hypoxanthine and acetic acid (?). Uric and formic acids were not detected. The other substances (leucin, &c.), which might possibly have been present, were not sought for, on account of the small amount of material at hand.

From these facts it would seem, then, that pathologically hypoxanthine is the most important abnormal constituent, since late investigations have shown especially that normal blood does not contain it, while a field still remains open to determine the exact nature of the nitrogenized element that has so constantly appeared as a companion to leucocythemia.

LV.—On certain Flame Reactions of Silver.

BY M. B. HARDIN.

In the latter part of December, 1875, while passing around the laboratory, I observed that a number of the students, who were at the time engaged in analysis by Bunsen's flame reactions, had upon their porcelain basins, films of unusual appearance and singular beauty. Upon

* Considered by some as a normal constituent.

† By Salkowski and Gorup-Besanez, though it may have possibly been found in the other cases also.

mentioning the matter to the laboratory instructor, adjunct professor J. H. Morrison, he stated that the substance given out for examination was silver nitrate, that the students had been unable to identify the films, that the reactions had been first obtained by Mr. A. M. Payne of the 2d class, and that he had himself repeated the experiments with similar results.

As it seemed important to determine the nature of these incrustations, and to ascertain whether silver and its compounds generally, would yield such films, I made a series of experiments, with the following results. The nitrate, chloride, and sulphide of silver, and the metal itself, were successively tried, and films were readily obtained in each case. The reactions occurred not only with the flame of the petroleum gas in ordinary use here, but also when a jet of purified hydrogen or a flame of an alcohol lamp was employed, though in the last instance the films were faint and not well defined.

The general character of the films was the same, no matter whether an asbestos thread or a platinum wire was used as the support.

It was found wholly unnecessary to have water in the basin, though the films obtained in the two cases differed in some respects from each other.

The *films formed upon a basin filled with cool water* were first examined.

Those obtained just above the upper reducing flame were yellow—orange to brown in thick parts. When a comparatively thick incrustation was procured, there was a central spot of silvery white, surrounded by narrow, lustrous rings of blue and violet tints; the whole environed by a zone of purple, shading off through pink into delicate hues of orange, yellow, and buff.

The films obtained just above the upper oxidizing flame were dove colored, violet-gray, or smoky, pale brown to colorless in thin parts. When a thicker film was procured, the central spot was dark violet-gray to smoky brown; this was surrounded by a pale, brownish yellow or colorless ring, and the whole encircled by a zone of purple, pink, and buff tints.

When the yellow or orange films, formed in the reducing flame, were exposed to the upper oxidizing flame, they became immediately some shade of purple or violet. This change occurred even in the act of withdrawing a yellow film from the flame; and in order to prevent it, it was found necessary to interpose something—a piece of sheet iron, for example—before removing the basin.

All of these films were easily shown to contain silver by the following reactions: They dissolved in tolerably strong nitric acid, and the solutions thus formed yielded a white precipitate with hydrochloric

acid, which was readily soluble in ammonia. When exposed to the vapor of nitric acid, dried at a gentle heat, breathed upon, and touched with a glass rod moistened with a dilute solution of potassium chromate, crimson streaks were formed. When flamed with alcohol holding iodine in solution, they became pale yellow.

When these iodide films were exposed to air saturated with ammonium sulphide they turned brown.

Experiments were then made to ascertain whether the differently colored films obtained respectively in the inner and outer flame had the same or different composition.

The thicker parts of the films, formed in the reducing flame, did not dissolve sensibly in ammonia or in sodium hyposulphite; they were scarcely affected by cold nitric acid of less specific gravity than 1.20; but readily soluble in stronger acid without unusual phenomena. They did not affect litmus or turmeric paper, but turned purple or violet when treated with ferric chloride. When yellow or orange, they could not be burnished on the basin, but were easily rubbed off by dry filter paper, and the grayish coating formed upon the paper became silvery-gray, when burnished. The thicker blue and silvery-white films were more or less lustrous before burnishing; and when moistened with water, or better with dilute nitric acid, they could be detached from the basin; but owing to want of tenacity, they rapidly broke up into irregular particles, which glistened with an unmistakable lustre.

It appears, therefore, that the central and most characteristic parts of the films formed in inner flame consist of metallic silver, the variations in color being due to difference in thickness of the films.

The films formed just above the upper oxidizing flame were alkaline, turning red litmus blue, and turmeric brown; and this after they had been well washed with distilled water, and the washings shown by Nessler's re-agent to be free from ammonia.

The violet-gray and smoky-brown parts were somewhat slow in responding to litmus paper, but after a little exhibited a distinct alkaline reaction.

When heated in the air bath, they commenced to lose color at 100° C., and at 125° C. changed completely to pale yellow or brown, nearly colorless. When heated to 100° C. in hydrogen, they lost color and water was formed. When touched with a drop of nitric acid of specific gravity 1.20 or upwards, they dissolved, forming a brown solution.

When a test tube well coated with one of these films was snugly inserted in another, containing a few drops of strong nitric acid, the film dissolved, forming a rich, dark brown solution. The experiment succeeded best when the tubes were kept cold by snow or ice. When a tube similarly coated was immersed in aqua ammonia, the film dissolved

with effervescence. The violet-gray, dove colored, and smoky-brown parts consist, therefore, chiefly of silver dioxide.

The pale brown to colorless portions were strongly alkaline, turning litmus blue and turmeric brown immediately. When heated above 250° C. they lost the alkaline reaction. When heated to 100° C. in hydrogen they also lost the alkaline reaction, and water was produced. They dissolved readily in nitric acid of specific gravity 1.10 without unusual phenomena; and were promptly soluble in ammonia and sodium hyposulphite. The pale brown and colorless films consist, therefore, of silver monoxide.

The purple and pink zones, surrounding the central parts of all the films, were slightly alkaline. They became yellow at 250° C., and yielded water when heated to 100° C. in hydrogen. When treated with aqua ammonia they changed to yellow, and the ammonia running off was found to contain silver. Sodium hyposulphite turned them dirty buff or gray. Contact with zinc under water caused them to become yellow; copper and tin had a similar effect, but slowly; iron did not produce the change. Stannous chloride, and dilute acids generally, also transformed the purple into yellow films. When burnished they became dark steel-blue and lustrous. The purple and pink portions of the outer zones are, therefore, mixtures of metallic silver and silver oxide—or films of metal coated with films of oxide. The outer buff-colored parts of all the films were, by similar tests, shown to be chiefly metallic silver in a very finely divided and non-coherent condition.

The *films formed upon an empty porcelain basin* were next examined.

Those obtained just above the upper reducing flame were bright lemon yellow—thick parts orange, brown, blue, &c., resembling the corresponding films previously described, except that the tints were brighter. They were found to consist of metallic silver.

The films formed above the upper oxidizing flame were pale, brownish yellow to colorless—outer parts purple, ruby red and yellow. The inner portions were found to be silver monoxide, the outer varying mixtures of the metal and the oxide.

It is evident, therefore, that the main difference between the oxide films formed upon a basin filled with water, and those obtained upon an empty dish, is, that in the former case, the films are chiefly dioxide, in the latter monoxide.

As the films thus far obtained varied somewhat under circumstances, which appeared almost identical, an effort was next made to determine the cause of the variation, so as to place the production of the differently colored films more under control.

The lamp was provided with a conical chimney, the gas flame ad-

justed so as to be about eight centimetres high, and the supply of air so regulated, that the upper reducing flame was barely visible. Pure precipitated silver was employed and introduced into the flame by means of a platinum wire, upon the end of which it was fused. The porcelain basin was supported just around its rim by a ring or triangle of wire. The silver was held in the tip of the upper reducing flame, for although the metal was volatilized more rapidly in the zone of fusion, or in the lower oxidizing flame, yet under these circumstances little globules of silver were mechanically projected against the basin; and from this and other causes the phenomena were to some extent altered. By proceeding in this way very beautiful and uniform results have been obtained; the only variations occurring being directly traceable to the thickness of the films.

BASIN FILLED WITH WATER (BELOW 100° C.)

Films just above the upper reducing flame:

Yellow, thick parts orange or brown; sometimes a narrow purple ring between the outer yellow and inner brown.

As these films increase in thickness, the central spot becomes some shade of violet or blue, and finally silvery white. These films are all metallic, except the purple ring, which contains a little silver oxide.

Films just within the upper oxidizing flame:

A central brown or yellow spot of metallic silver, surrounded by a series of concentric rings, arranged in the following order from the center:

1. Pale brown or colorless ..... Silver monoxide.
2. Violet-gray, dove colored ..... Silver dioxide.
3. Pale brown or colorless ..... Silver monoxide.
4. Delicate purple ..... Silver and its monoxide.
5. Pink to flesh colored ..... Silver and less monoxide.
6. Buff ..... Chiefly metallic silver.

As the films increase in thickness, the central spot undergoes changes already mentioned, and the rings vary somewhat also.

Films an inch or two above upper oxidizing flame:

Central spot—violet gray, dove colored, or smoky ..... Silver dioxide.
A ring—pale brown or colorless ..... Silver monoxide.
A zone—blended purple, pink, and buff tints ..... Varying mixtures of silver and silver oxide.

When first formed, these films are pinkish buff throughout. As exposure continues, the center becomes colorless or pale brown (silver monoxide); this spot then enlarges, and a violet-gray nucleus (silver dioxide) makes its appearance, the colorless part taking the form of a ring, which increases in diameter as the dark gray nucleus dilates.

BASIN EMPTY (125° TO 200° C.)

Films just above reducing flame:

Bright lemon yellow, thick parts orange to brown; when very thick, purple, violet, blue, or silvery. These films are all metallic.

Films just within upper oxidizing flame:

A central brown or yellow spot of metallic silver, surrounded by rings:

1. Pale brown or colorless .....Silver monoxide.
2. Delicate violet and pink zone.....Silver and monoxide.
3. Narrow purple or red ring .....Silver and less monoxide.
4. Lemon yellow .....Chiefly metallic silver.

Films an inch or two above upper oxidizing flame:

Central spot pale brownish-yellow or colorless .....Silver monoxide.
A ring of pale purple and pink tints.....Silver and monoxide.
A zone of light yellow.....Chiefly metallic silver.

Although some of these films have been described as formed within the upper oxidizing flame, it is, of course, understood that the basin, on account of its comparatively low temperature, does not actually come in contact with the flame. It should also be observed that in these positions of the basin there are three principal parts in every film: a metallic spot corresponding with the reducing flame, a zone of oxide corresponding with the oxidizing flame, and a belt of finely divided silver swept beyond the outer flame.

When a yellow metallic film, on the basin filled with water, is held above the upper oxidizing flame, the color passes through shades of purple and violet, into pale brown or colorless monoxide, and finally becomes dove colored or violet-gray dioxide.

When a yellow film upon an empty basin is similarly exposed, the colors obtained are beautiful, and the changes occur in the following order:

Yellow, orange, red, purple, violet, deep blue, pale blue (occasionally pale green), pale brownish yellow or colorless.*

As the films become more strongly alkaline with each succeeding tint, and as the final pale brown or colorless films are almost pure silver monoxide, it is evident that the color changes are intimately connected with the thickness of the film of oxide. The oxidation of the silver seems to be effected by the ozonized air surrounding the oxidizing flame.

The color changes described above have been imitated by exposing yellow films of silver to air and oxygen ozonized by electricity, while

* See *Proc. Amer. Chem. Soc*, vol. I, No. 2, and *Amer. Chemist*, Oct., 1876, interesting paper by I. Walz.

they have not been produced by exposure to ordinary oxygen at any temperature.

Moreover, if a piece of filter paper, moistened with a solution of potassium iodide and starch paste, is laid upon the outside of a porcelain dish, and the dish, filled with water, is then depressed a little way within the gas flame, a blue ring is invariably formed above the outer flame, corresponding exactly in diameter and breadth with the silver oxide films formed under similar circumstances.

If silver films collected upon a large watch glass are viewed by directly transmitted light, they resemble closely those obtained upon a porcelain basin. The resemblance is rendered perfect by fitting the coated watch glass over the bottom of a clean porcelain dish, and holding it so, that the eye may be directly above the center of the film.

If, however, the watch glass is held so, that the films are seen by reflected light, the phenomena are reversed, and the color of each ring is the complement of the color of the same ring as seen by transmitted light.

It appears, therefore, that the beautiful and varying colors of the films of silver and its oxides are mainly due to the interference of light. The phenomena are for the most part the colors of thin plates viewed by transmitted light, modified to some extent by irregular reflection.

In conclusion, experiments were made to determine the delicacy of these silver reactions.

First, a specimen of silver ore, containing three per cent. of silver as sulphide, mixed with sulphides of lead and copper, was tried. Two millegrammes, roasted in upper oxidizing flame, and then held in upper reducing flame, gave a rather faint, but unmistakable reaction. About 0.00006 gramme of silver was therefore detected.

In the next place, a little pure silver was fused upon a platinum wire. The increase in weight of the wire was 0.0008 gramme. This silver bead gave thirty-nine distinct films; then reaction ceased and the platinum wire was found to have regained its original weight. In this case about 0.00002 gramme of silver was sufficient to give the reaction.

A solution of silver nitrate was then made containing 0.00001 gramme of silver in each cubic centimetre. Five cubic centimetres of this solution, evaporated nearly to dryness and taken up on a small piece of filter paper, gave characteristic films, which dissolved in nitric acid, forming a solution which became turbid on addition of hydrochloric acid, and clear again upon treatment with ammonia. Two cubic centimetres of the silver nitrate solution gave a distinct film; and even one cubic centimetre responded to the test.

As some of these experiments were purposely made under rather

disadvantageous circumstances; and as even very distinct films, collected upon a thin porcelain crucible lid, were incapable of turning a delicate chemical balance, it may be safely concluded that about 0.00005 gramme of silver is generally sufficient to furnish satisfactory deposits, and that, under favorable conditions, as little as 0.00001 gramme of the metal can be detected.

The experiments detailed in this paper suggest, that, by a slight modification of the ordinary mode of proceeding, silver may be without difficulty detected in the presence of more volatile metals, and that other metals, not commonly ranked as volatile, may be found to yield films upon a porcelain basin.

However this may be, the following points appear to be established:

1. The volatilization of silver and the formation of films of this metal by the flame of a Bunsen's burner.
2. The oxidation of silver films by the ozonized air surrounding the upper oxidizing flame.
3. The application of these reactions to the detection of minute quantities of silver.

LVI.—On Areometers. Part I.

BY A. BOURGOUGNON.

BEAUMÉ'S AREOMETERS.

Beaumé constructed his areometers in 1768, and a description of these instruments is given in his "Eléments de Pharmacie."*

The first areometer described, was employed for the determination of the quantity of salt contained in each "quintal" of water, and its author remarks that this areometer is to be trusted only for the salt from which it has been graduated, since every salt does not give the same indications with this instrument; for example, one pound of saltpetre does not give quite one degree, and about two pounds of sugar are required to give one degree. Different instruments were then constructed, and graduated with different kinds of salts, but Beaumé remarks that it is far better to have only one instrument correctly graduated with the sodium chloride solution, using at the same time a table containing the proportions of each salt corresponding to each degree of the areometer. The graduation of this instrument, which sometimes is called *salimeter*, is obtained by means of water for the first point, and a solution of sodium chloride for the second. This solution of salt

* Beaumé. Eléments de Pharmacie. Paris, 1797. Vol. I.

is made by dissolving 15 parts, by weight, of salt in 85 parts of water, making 100 parts. Zero corresponds to the first point and 15 to the second. The space between these two points is divided into 15 equal parts, and these parts or degrees are used as a standard for the complete graduation of the areometer.

The other areometer of Beaumé was constructed with the view to determine the quantity of alcohol in spirituous liquids, which instrument is sometimes called alcoholometer.

Two points are also necessary for the graduation of this instrument. Water was selected for the first point, and a solution of sodium chloride was employed for the second. This solution of salt is prepared by dissolving 10 parts, by weight, of salt in 90 parts, by weight, of water, making 100 parts; 10 corresponds to the first point given by water, and 0 to the second, obtained with the salt solution. The space between 0 and 10 is divided into ten equal parts, and these divisions or degrees are employed as a standard to complete the graduation of the instrument.

It must be mentioned, that when Beaumé constructed his areometers, he had not in view the objects, for which they are now employed. One of these instruments was to be used as a salimeter, and the other as an alcoholometer, without regard to the specific gravity.

Now both these instruments are extensively used, and tables are given where the areometric degrees correspond to densities. Unfortunately, these tables do not agree with each other. Sometimes very appreciable differences exist. This, combined with careless construction, which often occurs in cheap instruments, is likely to cause misunderstanding between parties were these areometers are used as a standard.

It is our object, in this communication, to examine the construction of these areometers, and endeavor to give true formulas for the conversion of areometric degrees into corresponding specific gravity, and we must first begin by recalling briefly the general theory of hydrometers similar to those constructed by Beaumé. Let V be the volume of an areometer immersed in a liquid whose density is d. Vd then represents the weight of the liquid displaced, which is also the weight of the areometer. If V'd' represents the corresponding values for another liquid, we shall have:

$$Vd = V'd' \text{ or } \frac{d}{d'} = \frac{V'}{V}$$

that is the densities are inversely proportional to the volumes immersed. Now let $d_1, d_2, d_3, \ldots\ldots$ be a series of densities in a decreasing order, and $V_1, V_2, V_3, \ldots\ldots$ the corresponding volumes immersed, in an ascending order, we shall have:

$$\frac{d_1}{\frac{1}{V_1}} = \frac{d_2}{\frac{1}{V_2}} = \frac{d_3}{\frac{1}{V_3}}$$

$$\text{and} \quad \frac{V_1}{\frac{1}{d_1}} = \frac{V_2}{\frac{1}{d_2}} = \frac{V_3}{\frac{1}{d_3}}$$

If, then, we wish the divisions to indicate equal differences of density, we must arrange them to form a proportion with the volumes immersed. This implies, that the divisions approach each other as the density increases, provided, that the stem of the areometer has the form of a geometric cylinder.

The following investigations apply to areometers, whose divisions are equidistant, as those of Beaumé.

It is necessary, first, to have two divisions corresponding to two known densities. Let us call these divisions $n_1, n_2 \ldots$. reckoning from the upper extremity downward, and let the corresponding densities be $d_1, d_2 \ldots$. If we take for unity of volume one of the divisions, and represent the volume immersed by c, when the instrument is plunged to zero, it is evident, that, when the instrument is immersed to the n^{th} division (reckoning downward on the stem from zero), the volume immersed will be $c - n$; if the corresponding density is called d, $(c - n)d$ will represent the weight of the areometer; we will then have:

$$(c - n_1)d_1 = (c - n_2)d_2 \text{ whence } c = \frac{n_1 d_1 - n_1 d_1}{d_1 - d_2}$$

This value of c may be calculated once for all.

The density D corresponding to a division N will be found by the equation:

$$(c - N)D = (c - n_1)d_1 \text{ whence } D = \frac{c - n_1}{c - N}$$

Supposing that d_1 represents the density of water as unity.

We will now apply this theory to Beaumé's areometers.

A. *Beaume's areometer for liquids heavier than water.*

We have seen that the salt solution employed for the graduation of this instrument was obtained in dissolving 15 parts of salt in 85 parts of water; the specific gravity of this solution is 1.116.* Referring to the formula above given, we have here:

$$n_1 = 0;\ d_1 = 1;\ n_2 = 15;\ d_2 = 1.116$$

$$\text{whence} \quad c = \frac{15 \times 1.116}{0.116} = 144.31$$

and the specific gravity corresponding to the areometric degree, will be given by the formula:

$$\frac{144.31}{144.31 - N} = D$$

* Codex Medicamentarius. Pharmacopée française.

B. *Beaumé's areometer for liquids lighter than water.*

In this instrument, the point, to which it sinks in water, is near the bottom of the stem, and is marked 10; the zero of the scale is the point, to which it sinks in a solution of 10 parts of salt to 90 parts of water, the density of this solution being 1.0847.* The divisions in this case are numbered upward from 0.

In order to adapt the above formula to the case of graduations numbered downwards, it is necessary to reverse the signs of n_1, n_2, and N. Then we have:

$$c = \frac{n_2 d_2 - n_1 d_1}{d_1 - d_2} \text{ and } D = \frac{c + n_1}{c + N}$$

and as we have now: $n_1 = 10$; $d_1 = 1$; $n_2 = 0$; $d_2 = 1.0847$, the formula gives:

$$c = \frac{10}{0.0847} = 118.06$$

and

$$\frac{128.06}{118.06+N} = D$$

We have admitted *a priori* in these calculations, that the specific gravity of the salt solutions was known, but it is doubtful whether these numbers are correct, especially, if we consider the formula obtained for the conversion of areometric degrees into density for the areometer for liquids lighter than water.

Beaumé has omitted to give these specific gravities, and we do not know if the salt to be used must be pure, or only the common salt. Beaumé directs that very pure and dry salt be employed; but perhaps these words do not mean chemically pure, since we see, that other authorities use common salt.

The composition of common salt not being constant, it follows that the density of the salt solution may vary with almost every operator; hence we conclude, that it is far better to find these densities by calculation.

(*a*) We will first begin with the areometer for liquids heavier than water.

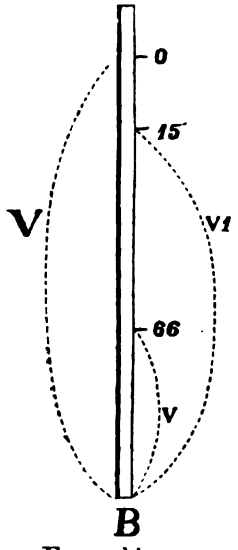
To carry out satisfactorily this calculation, we must remember that Gay-Lussac has observed that the areometer, immersed in monohydrated sulphuric acid of 1.8427 density, marked 66 degrees. He took this point as a first, and the second point 0 was obtained by immersing the areometer in water. He then divided the space between 0 and 66 in sixty-six equal parts or degrees. The verification of areometers constructed upon this principle is an easy matter, Gay-Lussac having estab-

* Codex Medicam., loco citato.

lished a relation between the areometric degree and the density, and this density can always be verified by the balance.

To calculate the specific gravity of the salt solution employed to gradute the areometer, we will imagine an instrument having the form of a geometrical cylinder.

Now, we know by experiment that the degree of 0 corresponds to the density 1.000, and the degree 66 to the density 1.8427 (Gay-Lussac).



Let V represent the volume of the areometer from 0 to the lower extremity B; v the volume from 66 to B, the volumes immersed being inversely proportional to their densities, we will have:

$$\frac{V}{v} = \frac{1.8427}{1} \text{ or, } \frac{v + 66}{v} = 1.8427$$

$$v + 66 = 1.8427\, v$$

$$66 = 0.8427\, v$$

$$\frac{66}{0.8427} = v = 78.319$$

Then from the 66th degree to the lower part of the cylinder we obtain 78.319 divisions, supposing that this cylinder be divided into equal parts to those between 0 and 66. The value of V will be:

$$V = v + 66 = 78.319 + 66 = 144.319$$

From this we conclude that the number of degrees from 0 to B is 144.319; and that the relation of one degree of the areometer is to the volume of the areometer as $\frac{1}{144.319}$

Finally we obtain:

$$V - v' = 15 \quad \text{or, } 144.319 - v' = 15$$

$$144.319 - 15 = v' = 129.319$$

representing the number of degrees from 15 to B.

From these data we will obtain the density of the salt water used for the graduation of the instrument. Calling D the density corresponding to the 15th degree, we have:

$$\frac{V}{v'} = \frac{D}{1} \text{ or, } \frac{144.319}{129.319} = 1.1159$$

a number very near 1.116 used in the former calculation, and adopted *a priori*.

It follows that to reduce areometric degrees given by this instrument into corresponding densities, the modulus 144.319 is to be employed.

Another number for the specific gravity of monohydrated sulphuric acid, SH^2O^4 has been given. Payen, in his "Traité des réactifs," * says that the 66th degree of Beaumé's areometer corresponds to the density 1.845; although, in a table given in this work, the 66th degree corresponds to another density. Brande, in his manual of chemistry,† gives the specific gravity of monohydrated sulphuric acid equal to 1.8455. L. Playfair, as I was informed by Mr. P. Casamajor, gives more recently the number 1.845.

Now, in the above calculations, if we take for specific gravity of the acid SH^2O^4, the number 1.845, we obtain the following values:

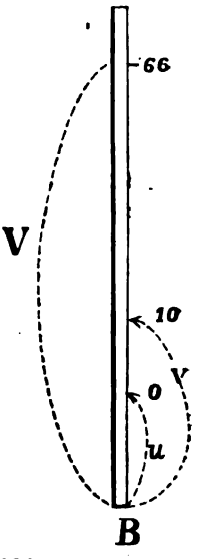
$$v = 78.106$$
$$V = 144.106$$
$$v' = 129.106$$
$$D = 1.1163$$

and the modulus used in the formula becomes 144.106.

(*b*) We will now consider the areometer for liquids lighter than water, and we will conduct our investigation on the same plan as for the other areometer.

This areometer regulates the sale of petroleum and its products, and also, in certain countries, the sale of sulphuric ether.

Well rectified sulphuric ether of a density of 0.720 marks 66° on this areometer,‡ and upon this fact we will base our calculation relative to this instrument.



We know by experiment that to the degree 10 corresponds the sp. gr. 1.000; and to the degree 66, the density 0.720. The volumes immersed being inversely proportional to their densities, we have:

$$\frac{V}{v} = \frac{1}{0.720} \text{ or, } \frac{v + 56}{v} = 1.388$$
$$v + 56 = 1.388\ v$$
$$56 = 0.388\ v$$
$$\frac{56}{0.388} = v = 144.329, \text{number}$$

representing the number of degrees from 10 to B.

The value of V will be:

$$V = v + 56 = 144.329 + 56 = 200.329$$

and the value of v', or the number of degrees from 0 to B is equal to:

$$v' = v - 10 = 144.329 - 10 = 134.329.$$

* Payen Traité des réactifs, Paris, 1825.

† W. T. Brande—A manual of Chemistry, London, 1841.

‡ Codex Medicam., loc. citat.

From the construction of the areometer, the formula employed for the conversion of areometric degrees into density will be:

$$\frac{144.329}{134.329+N} = D$$

From this calculation we will find the specific gravity of the salt water used for the graduation of the instrument by the following proportions, calling D the density corresponding to 0°:

$$\frac{V}{v'} = \frac{D}{1} = \frac{144.329}{134.329} = 1.0744$$

a number differing widely from 1.0847, used in a former calculation.

The modulus 144 is often employed in the formulas given for the transformation of areometric degrees for the areometer for liquids heavier than water. Some authors, taking in consideration the construction of the instrument for liquids lighter than water, conclude that the formula

$$\frac{144.}{134 + N} = D$$

must be employed; but this reasoning cannot be admitted, since the saline solution used for the graduation of the two areometers varies in density, and one of the two areometers marks 0 in water, and the other 10. Although instruments are made in which the two areometers are combined in one, the point 0 being in the midst of the stem. We never had the opportunity to verify the correctness of such instruments.

The question of areometers is not yet decided, since we find authorities taking as modulus numbers different from those given in this communication.

During the course of our last meeting, at the conclusion of the interesting communication upon this subject by our colleague, Mr. P. Casamajor, our president, Dr. C. F. Chandler suggested that the *American Chemical Society* should carefully investigate the question of areometers, and determine the correct method to be employed in their future construction.

Such a proposition should be unanimously adopted by our society; it would have the double end of furnishing science and industry with accurate instruments, and avoid misunderstandings arising from the use of cheap, untrustworthy areometers.

Before closing this communication, I will make the remark that, in Prussia, areometers, alcoholometers, &c., are verified and stamped exactly as weights, balances, and measures of capacity. In other countries the fabrication of these instruments is not regulated by any law. It is the duty of those employing areometers to have them verified by experts. One of my friends relates that a manufacturer in the north of France, by using an areometer showing a difference of one degree in its scale, suffered a loss of 40,000 francs.—(*To be continued.*)

LVII.—Proceedings.

Regular Meeting, Thursday, June 7th, 1877.

The meeting was called to order at 8 P. M. Vice-President Chandler in the chair. The minutes of the last meeting were read and approved. On recommendation of the Council, the following resolutions were adopted:

1. That the year of the Society shall date from January 1st.
2. That the first volume of the Proceedings of the Society shall include the numbers for 1876 and 1877.
3. That all members joining the Society before the end of 1877 shall be entitled to the first volume of the Proceedings.

With reference to an invitation from Prof. N. T. Lupton, to attend the annual meeting of the American Association for the Advancement of Science, at Nashville, Tenn., it was thought best to express the Society's thanks for the invitation, but to decline to take part as a body.

The matter of having the Society incorporated by the Legislature of the State of New York was discussed; but, on motion of Dr. Goldmark, action on the subject was deferred.

The following were elected:

As members—Dr. W. H. Gregg, Elmira, N. Y.; Dr. Edgar F. Smith, Phila., Pa.

As associate—Gen. John Newton, N. Y.

Mr. A. Bourgougnon read the second part of a paper "On Areometers;" the second paper read was "On the Solubility of Arsenic Trioxide in Coffee Decoctions," by Dr. Chas. McIntyre. Neither of these called for any special discussion.

Mr. Casamajor presented the following communication:

Messrs. Havemeyer & Elder have presented to the library of the American Chemical Society their entire collection of Dingler's Polytechnisches Journal, from 1860 to 1876, being seventeen years of this valuable publication. Unfortunately twenty-five numbers are wanting in this series. In the hope that we may be able to obtain these numbers from those who can spare them, I now request that this notice may be published in the proceedings of the Society. The full list of the missing numbers is as follows:

1860—No. 899.

1861—No. 933.

1863—Nos. 961, 962, 963, 964, 965, 966, 967, 968, 970, 971, 972, 979, 980, 984.
1864—Nos. 985, 986, 987, 988, 989, 990.
1866—No. 1038.
1867—No. 1066.
1868—No. 1081.
1871—Nos. 1167, 1168.
1873—No. 1204.

Mr. Casamajor's request was granted, and he was charged to convey the thanks of the Society to the Messrs. Havemeyer & Elder for their donation.

Prof. Egleston called the attention of the Society to a specimen of ferro-silicon, insoluble in aqua regia, and containing 16 % of Si. The production of this substance will, in Prof. Egleston's opinion, prove of the utmost importance in the manufacture of cast steel, as it tends to prevent the formation of carbonic oxide, which gives rise to the "blow-holes." In his further remarks, Prof. Egleston gave some outlines of the progress recently made in the manufacture of iron and steel, especially of "spongy" iron direct from the ore; and ventured the prediction that we are at the eve of a complete revolution of this branch of industry, the tendency being the production direct from the ore of wrought iron and steel, in which direction some great strides have been made of late.

The following were proposed:

As members—Dr. Hanbury Smith, N. Y.; Ch. Lecompte, Tenafly, N. J.; Auguste J. Rossi, N. Y.; Benj. P. Blanpied, Hanover, N. H.

Adjourned.

LVIII.—On Areometers. Part II.

BY A. BOURGOUGNON.

CARTIER'S AREOMETER.

We have met with some difficulty in establishing formulas for the areometers of Beaumé. If we try now to obtain similar formulas for the instrument of Cartier, the difficulty is still greater, since four processes have been employed for the graduation of this instrument.

When Beaumé constructed his *pese-liqueurs* it was at once adopted by the manufacturers, but rejected as an official instrument. The reason of this rejection was, that the members composing the "Ferme Générale" had no great sympathy for Beaumé, who had just published

several memoirs attacking strongly the new chemical doctrines. It is sufficient here to remark, that Beaumé was one of the last supporters of the celebrated theory, imagined by Becher and developed by Stahl.

Another reason, for which the alcoholometer of Beaumé was not officially adopted was, that by its use the manufacturers were able to ascertain the duties they had to pay for alcohol. According to the ideas of the "Ferme Générale," Brisson, produced an areometer constructed upon the principle of Fahrenheit's, and also Montigny, but these two areometers were soon forgotten.

It was then agreed to employ the *pese-liqueurs* of Beaumé, with a slight modification in its construction, and the *pese-liqueurs*, thus modified by the "Ferme Générale," received the name of Cartier's areometer.

Let us now examine the different processes employed in constructing this areometer.

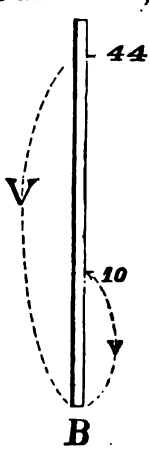
1. Areometer of the "Ferme Générale." This instrument is the hydrominor areometer of Beaumé, on which the 32d degree is marked 30 in the new instrument.

2. Another process of constructing the areometer of Cartier, was the following: The same areometer of Beaumé is still employed, and from the 22d degree, above and below, 16 degrees of Beaume are divided into 15 equal parts. For this instrument, we find the following relations:

The 22d degr. of Beaumé corresponds to the 22d degr. of Cartier.
" 6th " " " " 7th " "
" 38th " " " " 37th " "

32 degrees of Beaumé are equal to 30 degrees of Cartier.

We will not try to calculate the formulas for these two instruments, in which the graduation is too arbitrary, and we will only examine the two following areometers of Cartier now in use.



3. In this areometer, the point 10 corresponds to water, and the point 44 to the number 0.795 representing the density of absolute alcohol at +15° C.

Calling V the volume of the instrument from the 44th degree to the inferior part B, and v the volume from 10 to B, we have:

$$\frac{V}{v} = \frac{1}{0.795} \text{ whence } \frac{v+34}{v} 1.257$$

$$v + 34 = 1.257\ v$$

$$\frac{34}{0.257} = v = 132.39$$

and the conversion of areometric degrees furnished by

this instrument into corresponding density, will be given by the formula:

$$\frac{132.29}{122.29+N} = D$$

in which N represents the number of degrees indicated by the instrument.

4. The zero of the areometer corresponds to water, and the 44th degree to the density of absolute alcohol at +15° C. We have here:

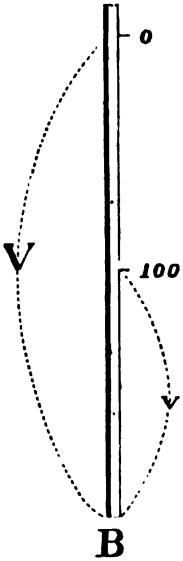
$$\frac{V}{v} = \frac{1}{0.795} \text{ whence } \frac{v+44}{v} = 1.257$$

$$v = \frac{44}{0.257} = 171.2$$

and to reduce the areometric degrees given by this instrument the modulus 171.2 is to be employed.

THE LACTOMETER.

We refer here only to the instrument adopted by the New York Board of Health, in which the zero corresponds to water at the temperature of 60° Fahr., and the point 100 to the specific gravity 1.029 at the same temperature. We have:



$$\frac{V}{v} = \frac{1.029}{0.999125} \text{ whence } \frac{v+100}{v} = 1.0299$$

$$v + 100 = 1.0299\ v$$

$$v = \frac{100}{0.0299} = 3344.48$$

The number of degrees from 100 to the inferior part B of the instrument, is 3344.48. Then we obtain for the value of V:

$$V = v+100 = 3344.48+100 = 3444.48$$

The relation between the volume of one degree of the lactometer and the volume of the instrument, is equal to $\frac{1}{3444.48}$, and if we call N the lactometric degree, we obtain the following formula for the reduction into corresponding specific gravity:

$$\frac{3444.48}{3444.48 - N} = D$$

In a former calculation, we found the number 3548 as modulus for the lactometer. This number was obtained by means of the following data: $n_1 = 0$; $d_1 = 1$; $n_2 = 100$; $d_2 = 1.029$; but on inquiring about the construction of this instrument, we were told, that the water used in the determination of the point zero was at the temperature of 60° Fahr.; then the value of d_1 becomes equal to 0.999125, and the former mod-

ulus 3548, obtained for the density of water equal to 1.000, becomes now 3444.48.

The above calculations, concerning the lactometer, are made supposing that the degrees are equidistant.

We have now reviewed the principal areometers employed, and it is with reason, that we omit to speak of the areometer of Balling, Mr. P. Casamajor having discussed this subject with the authority pertaining to him in this matter, and having shown that the modulus to be employed for the reduction into density is 260.

We will now examine the instruments called densimeters.

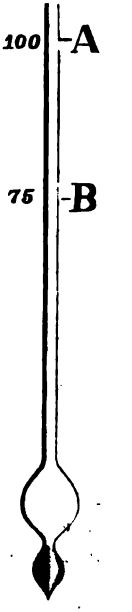
DENSIMETERS.

Densimeters are areometers graduated in order to show the relative specific gravity of a liquid, according to the degree to which they plunge in this liquid.

We will describe only the instruments of Gay-Lussac called volumeters.

The volumeter of Gay-Lussac is similar in form to the areometer of Beaumé, it differs only in the graduation, which varies as the instrument to be employed is a hydromajor or hydrominor areometer.

In the first case, it is loaded, in order that when immersed in pure water it will plunge to the point A, situated at the upper part of the stem. Then selecting a liquid, whose density is known and greater than that of water, in the ratio of 4 to 3 for example, the volumeter is immersed in it.



It plunges now to the point B. If we represent by V and v the volumes immersed respectively in water, and in the second liquid, the volumes being inversely proportional to the density of the liquids, we have:

$$\frac{V}{v} = \frac{4}{3} \text{ whence } v = \frac{3}{4} V$$

If we represent by 100 the volume V, the volume v will be 75. Consequently the numbers 100 and 75 are respectively inscribed at the points A and B; the volume AB according to the value of v, being one-quarter of V, the distance comprised between A and B is divided into 25 equal parts, and each of these parts is $\frac{1}{25}$ of AB, or $\frac{1}{100}$ of V, that is to say, of the volume immersed in pure water. Finally, the divisions are continued to the lower part of the stem.

To obtain the density of a liquid, it is necessary only to immerse in it the volumeter, and if this instrument sinks to the 54th division, for example, this indicates that the volume of the displaced liquid is represented by 54, the volume of water being represented by 100. Since all floating bodies displace a

weight of liquid equal to their own weight, it follows that the volume of water V, or 100, and the volume of the other liquid 54 have the same weight, the weight of the volumeter, but for equal weights the volume of two bodies is evidently in inverse ratio to their density ; therefore, if we represent by x the density of the second liquid, the density of water being 1.000, we have :

$$\frac{x}{1} = \frac{100}{54} \text{ whence } x = \frac{100}{54} = 1.85$$

If the volumeter is made for liquids lighter than water, the point 100, corresponding to distilled water, is situated at the lower part of the stem. To the upper part of the instrument a weight, weighing one-quarter of the volumeter is fixed. Now the weight of the volumeter alone being represented by 100, its actual weight is 125. This last number is inscribed on the stem at the point of intersection with the liquid, and the interval between 100 and 125 is divided into 25 equal parts, and these divisions are continued to the upper part of the stem.

Supposing that this instrument sinks in a liquid to the 130th division, the density x of this liquid will be :

$$\frac{x}{1} = \frac{100}{130} \text{ whence } x = 0.769$$

Let us examine now some important questions regarding the areometers.

In all the formulas, that we have given for the reduction of areometric degrees into corresponding specific gravity, we have not omitted to take into consideration the decimal parts of the modulus. This decimal part must not be neglected. It is always well to shorten the calculations, but this can be done only if the final results are not altered. In neglecting the decimal part in the modulus for the areometers of Beaumé, the results then obtained are erroneous, since they disagree with the data adopted as the basis of calculation. For example, in the hydromajor areometer, if we adopt for modulus 144, we arrive at the conclusion that the density of the acid SH^2O^4, is equal to 1.846 instead of 1.8427 adopted *a priori* as a base of calculation.

The question of the temperature of the liquids employed in the graduation of the areometers should not be forgotten. Amongst the areometers, that we have examined, we have found only the instruments of Gay-Lussac and the New York Board of Health lactometer, for which any mention is made relative to the temperature of the liquids used in their graduation. For the lactometer, we know that this instrument is graduated for the temperature of 60° Fahr., and we have adopted this datum as a basis for our calculations, relative to this instrument.

For the following, I will remark, that I have found a great deal of information in a publication called "La Sucrerie Indigène."

The hydromajor areometer of Beaume, modified by Gay-Lussac is no longer graduated by means of the salt solution; the two extreme points are obtained with water at the temperature of +4° C., and monohydrated sulphuric acid at the temperature of +15° C.

Objection has been made, that in the results furnished by the areometer modified by Gay-Lussac, there is a discordance, since the two extreme points are determined at different temperatures.

That this is an apparent discordance only, is sufficiently shown by remembering the decision of Gay-Lussac, which is applied not only to the areometer, but to the volumeter and alcoholometer. Gay-Lussac has adopted +15° C. as a normal temperature, and it is for this temperature, that the densities for the areometer and alcoholometer have been calculated.

It is then easy to understand how the zero of the areometer or of the alcoholometer determined by means of distilled water at +15° C. has a density equal to 1, the density being here the relation of the weight of an alcoholic or acid mixture at +15° C. to the same volume of distilled water at +15° C. Gay-Lussac having adopted for a unit of volume the liter, for which the weight of distilled water at +15° C. is 999.125 gr., the density of an alcoholic or acid mixture at the degree zero is identically

$$\frac{999.125}{999.125} = 1 = 1000$$

if it is agreed to multiply all the results by 1000.

Gay-Lussac obtained the numbers, representing the densities, by dividing the weight, previously taken in a vacuum, of a liter of the alcoholic or acid mixture at the temperature of +15° C. by the weight of one liter of distilled water, obtained under the same conditions.

Several numbers have been given as representing the density of the acid SH^2O^4. These different numbers having been adopted have furnished different results.

Gay-Lussac has admitted, with Guyton de Morveau and Vauguelin, that the areometer of Beaumé marks 66° in pure monohydrated sulphuric acid, and to free himself from any doubt about the value of the modulus, he determined the density of this acid and obtained the number 1.8427.

Gay-Lussac says:* "The most concentrated sulphuric acid that I have obtained, has a density of 1.8427 at the temperature of +15° C."

The more recent investigations of Marignac, upon this subject, confirm the number given by Gay-Lussac, and if we look at the table published by Bineau, we remark that the 66th degree of Beaumé corre-

* Gay-Lussac. Essai sur les Potasses. Paris, 1824.

sponds to sulphuric acid at the density of 1.842, the operation being made at +15° C. This acid is really the monohydrated acid SH^2O^4, Bineau having taken the precaution to give its composition.

EXTRACT FROM BINEAU'S TABLE.

Degree of the Areometer.	Density	The Temperature being 0° C.		The Temperature being +15° C.	
		Monohyd. Acid	Anhydr. Acid.	Monohyd. Acid	Anhydr. Acid.
		Per Cent.	Per Cent.	Per Cent.	Per Cent.
66.0	1.842	91.3	74.5	100.0	81.6
66.2	1.846	92.5	75.5		
66.4	1.852	95.0	77.5		
66.6	1.857	100.0	81.6		

In referring to the table of Bineau, we see that the same acid, having the same composition, has a specific gravity of 1.857 at 0° C, and marks 66°·6. From this, I think that we will readily admit that all the discussions having arisen concerning the density of sulphuric acid, are due only to a question of temperature.

Finally we will remark, that all the densities furnished by the instruments of Gay-Lussac, are given as having been obtained in a vacuum. In all scientific investigation, the density is always represented in this way, but in industry the density is understood to represent the weight of the unity of volume obtained in the atmosphere, at the normal temperature and normal pressure. For areometers, which are instruments used extensively in industry, the question must be asked, if the density has been obtained in the atmosphere or in a vacuum. Although the difference obtained in the two processes is small, in some cases this difference must be taken into consideration.

Let us apply the two methods for the hydromajor areometer of Beaume. We have the formula

$$\frac{144.319}{144.319 - N} = D$$

in which D represents the density as obtained in a vacuum. Let us call D′ the same density obtained in the atmosphere at the temperature of +15° C. under the pressure of 760 millimeters.

If we have glycerine marking 28°, its density, obtained in a vacuum, will be:

$$D = \frac{144.319}{144.319 - 28} = 1.2407$$

a quantity, which is equal to the weight of unity of volume of glycerine divided by the weight of unity of volume of water, these two weights being obtained in a vacuum at the temperature of +15° C. The weight of unity of water in this condition being equal to 0.999125, we will have, for the weight of the glycerine,

$$1.2407 \times 0.999125 = 1.239614$$

thus giving: $$\frac{1.239614}{0.999125} = 1.2407$$

Now if we will determine the density D′ of the same glycerine, we must remember that all bodies lose in the atmosphere a fraction of their weight, fraction equal to the volume of air displaced. We have then to substract from both terms of the above fraction the weight of a volume of air at +15° C. under the pressure of 760 millimeters. This weight being sensibly 0.0012, we finally obtain:

$$D' = \frac{1.2396 - 0.0012}{0.999125 - 0.0012} = \frac{1.2384}{0.997925} = 1.2408$$

The difference D′ − D = 0.0001.

The difference D′ − D increases with the density. If we make the same calculations for sulphuric acid, whose density obtained in vacuum at +15° C. is equal to 1.8427, we obtain for the value of D′ 1.8437, making a difference of 0.001, a small quantity, but which must not be neglected in cases where experts are called to determine the correctness of areometers.

Deg.B.	Sp. Gr.	Deg.B.	Sp. Gr.	Deg.B.	Sp. Gr.	Deg.B.	Sp. Gr.	Deg.B.	Sp. Gr.
0	1.0000								
1	1.0069	16	1.1246	31	1.2735	46	1.4678	61	1.7321
2	1.0140	17	1.1335	32	1.2849	47	1.4829	62	1.7531
3	1.0212	18	1.1424	33	1.2964	48	1.4983	63	1.7748
4	1.0285	19	1.1516	34	1.3081	49	1.5140	64	1.7968
5	1.0358	20	1.1608	35	1.3201	50	1.5301	65	1.8194
6	1.0433	21	1.1702	36	1.3323	51	1.5465	66	1.8427
7	1.0509	22	1.1798	37	1.3447	52	1.5632	67	1.8665
8	1.0586	23	1.1895	38	1.3574	53	1.5803	68	1.8909
9	1.0665	24	1.1994	39	1.3703	54	1.5978	69	1.9161
10	1.0744	25	1.2095	40	1.3834	55	1.6157	70	1.9418
11	1.0825	26	1.2197	41	1.3968	56	1.6340	71	1.9683
12	1.0906	27	1.2301	42	1.4104	57	1.6527	72	1.9955
13	1.0989	28	1.2407	43	1.4244	58	1.6719	73	2.0235
14	1.1074	29	1.2514	44	1.4386	59	1.6915	74	2.0523
15	1.1159	30	1.2624	45	1.4530	60	1.7115	75	2.0819

The above table shows the specific gravity corresponding to the degrees of Beaumé for liquids heavier than water at the temperature of +15° C.

The volume of the areometer at +15° C. is equal to 144.319.

LIX.—On the Solubility of Arsenic Trioxide in Coffee Decoctions.

BY CHARLES McINTIRE, A. M., M. D.

[Preliminary Notice.]

The solubility of arsenic trioxide was, for a long time, a property very indefinitely defined, on account of the disagreement of the results obtained by the many investigators. Prof. Wormley, in his "Micro-Chemistry of Poisons," details some experiments which clear the subject. He has shown, that a very slight variation of the conditions in performing the experiment exerts a great influence on the degree of solubility; so that now one is able to harmonize many of the previously obtained results.

The solubility of the oxide in the presence of organic material has received but little attention by the writers on toxicology, being usually dismissed with the statement, that the presence of organic matter decreases the solvent power of the liquid. Taylor (on Poisons, 3d Am. Ed. 287), quoting from Guy's Hospital Reports IV, 103, says: "The presence of organic matter in a liquid renders the poison much less soluble. Thus hot tea, with milk and sugar, and cold porter did not take up more than half a grain to the ounce; while hot coffee and cold brandy did not dissolve more than one grain to the fluid ounce."

Christison (1st Am. Ed. 202), speaking of its solubility in organic matter, says: "I have found that a cup of tea, left beside the fire at a temperature of 200° for half an hour upon two grains of the oxide, does not take up entirely even that quantity." Other authors confirm these figures by their assertion.

In a case of poisoning by arsenic, on trial in Northampton county, Penn., at the August term of 1876, the defendant, Laros, administered the arsenic by placing it in the coffee pot, in which was being boiled the coffee for the evening meal. Some of this coffee decoction was saved, and upon analysis I found it to contain 1 part of the oxide to 39 of menstruum, or about 12½ grains to the fluid ounce. As this was so much larger than the solubility quoted above, I made a few determinations before the trial, and a few more since, to determine a little more accurately the solubility of arsenic trioxide in coffee. It was my intention to increase the series considerably, tracing the effect of varying quantities of organic matter upon the solubility, and experimenting with other substances than coffee; other duties, however, prevent me from giving the proper laboratory attention at present, hence a preliminary paper. Two decoctions of coffee were prepared, by boiling 50 and 25 grammes of coarsely ground coffee in a liter of water. The arsenic trioxide used was powdered, one specimen being furnished by Messrs. Eimer & Amend, another marked "pure" coming from Messrs. Charles T. White & Co.

When using the Eimer & Amend specimen, the arsenic was determined as a sulphide. Since the sulphhydric acid precipitated at the same time the coloring matter of the coffee, this amount was approximately determined by submitting the coffee decoction to the action of the sulphhydric acid, and substracting the weight of the precipitate thus obtained from the arsenic tersulphide precipitates. This crude method was devised to obtain comparative results in time for the trial. In the other experiments (on the C. T. White & Co. oxide), the organic matter was destroyed by potassium chlorate and hydrochloric acid, and the arsenic determined as magnesium ammonium arseniate: using the precautions given by Fresenius, since I had not had the opportunity to test the recent changes proposed in this method.

Calling the decoction made from 50 grammes of coffee A, and that from 25 grs. B, the following table shows the results obtained by boiling 5 grammes of arsenic trioxide in 50 C.C. of the decoction for the time specified.

A.

Boiled for	Dissolved of Eimer & Amend's Specimen.	C. T. White & Co.'s Specimen.
One hour.....	1 part in 19.35	1 part in 22.6
Half hour.....	1 " " 26.9	1 " " 25.13

B.

One hour.....	1 part in 18.4	1 part in 16.44
Half hour.....	1 " " 21.4	1 " " 25.15

One gr. of the oxide was boiled for an hour with 40 c.c. of A and of B, and the solubility of the Eimer & Amend specimen is represented by 1 part in 48, and 1 part 40.6 parts respectively.

The boiling was done in small flasks covered with watch-glasses, while the evaporated water was replaced from time to time. The flasks were placed on a piece of backed gauze, heated directly with a Bunsen burner. It was quite difficult to perfectly adjust the size of the flame, so that the boiling of some was not carried on more violently than were others, and this may be a source of error in a substance so varying in solubility. A measured portion was filtered immediately at the expiration of the time, and the determination made in this portion.

There are not experiments enough recorded to draw very definite conclusions, but this much I think is apparent:

1. The old statement, that organic matter hinders the solution of arsenic, is confirmed, and the greater the amount of organic matter present, the less the solubility. These results however are not as high as Prof. Wormley's, obtained from experiments on like proportions.

2. The absolute solubility in organic matter is much greater than has heretofore been stated; so that large quantities of arsenic trioxide can be dissolved in coffee at least.

3. That the presence of the organic matter does not interfere with the usual influence of other conditions, *e.g.* varying proportions of oxide to solvent, length of time of boiling, &c., the same general relation being maintained, as when no coffee is present.

LX.—Proceedings.

Regular Meeting, Thursday, September 6, 1877, 8 *o'clock P. M.*

No quorum was present. The papers of E. F. Smith, Ph. D., on the Determination of Phosphorus in Cast Iron, and Prof. Chas. A. Goessmann, Contributions from the Agricultural Laboratory, were read. Adjourned.

M. ALSBERG, *Recording Secretary pro tem.*

LXI.—Determination of Phosphorus in Cast Iron.

BY EDGAR F. SMITH, Ph. D.,
Assistant in Anal. Chemistry, Univ. Penn'a.

Recently an article appeared in "Fresenius' Zeitschrift für Anal. Chemie," 2 Heft, p. 174, 1877, upon the estimation of phosphorus in iron ores, in which the writer calls attention to the different percentages of phosphorus obtained, when the ore was dissolved in nitric acid, and when aqua regia was employed as a solvent. In conclusion, others are advised not to use aqua regia, as in this case some phosphorus will evidently be lost.

I had occasion to make a number of similar determinations and noticing the varying percentages, had several tests made to ascertain about what amount of phosphorus was volatilized.

The following analyses, made with both nitric acid and aqua regia, were carried out by H. B. Stephens, S. B., to whom I would express thanks for his readiness and care in performing this work.

First Experiment. 5 grm. cast iron were placed in a rather large beaker, and provided with a cover, and nitric acid then added. After the first violent action had ceased, the beaker was placed upon a water bath and gently warmed, and finally its contents was evaporated to dryness. The residual mass was moistened with a little nitric acid and water, and the solution then filtered from the insoluble portion, which, after thorough washing and drying, was fused together with sodium carbonate. The fused mass was treated with nitric acid and water, then evaporated to dryness to render the silicic acid insoluble. The silicic acid was moistened with a few drops of nitric acid and some water, and the liquid

filtered and added to the first nitric acid solution above, and, after concentration, an excess of ammonium molybdate was added, and the liquid allowed to stand twenty-four hours. The yellow precipitate, that had formed, was filtered and well washed with a molybdenum solution, and then dissolved in cold ammonium hydrate. To this solution, rendered almost neutral by the addition of hydrochloric acid, a magnesia solution was added. The precipitated ammonium-magnesium phosphate was redissolved and again precipitated. It was perfectly white.

Percentage of phosphorus obtained=0.296%.

Second Experiment. In a rather large-sized flask, provided with a doubly perforated cork, were placed 5 grm. of the same ore as in Experiment 1. Through one perforation of the cork passed a funnel tube touching the bottom of the flask, while in the second perforation was fitted a glass tube, which, after being bent at right angles several times, dipped into a jar containing a solution of bromine in conc. hydrochloric acid. After securing the various parts of the apparatus, aqua regia was admitted into the flask through the funnel tube. The action at first was rather violent. When this ceased, the flask was very carefully heated, and as there was no longer any preceptible evolution of gas, the apparatus was disconnected. The contents of the flask were treated precisely as in Experiment 1. The percentage of phosphorus obtained from this portion amounted to 0.184%.

The hydrochloric acid solution containing bromine was carefully washed from the jar into a casserole, and evaporated to dryness upon a water bath. A slight residue remained, which was taken up with a few drops of hydrochloric acid. A little ammonium hydrate, then added, formed a small precipitate, which appeared to be iron, and was dissolved in nitric acid. To this solution was added ammonium molybdate. After standing twelve hours, a large precipitate had formed, which, treated as before described, gave 0.108% phosphorus. This percentage added to that obtained from the residue remaining in the flask, would about equal the amount found in the portion treated with nitric acid.

Aqua regia: 0.184% P.+.108% P. caught in jar=0.292% P.
Nitric acid solution gave . . . . . 0.296% P.

All the reagents used in these experiments were examined for phosphorus before being employed in the analyses.

Third Experiment. 5 grm. cast iron dissolved in nitric acid gave 0.1292% phosphorus.

Fourth Experiment. 5 grm. cast iron dissolved in aqua regia, using a flask and bromine solution, gave 0.10% P.+portion volatilized, 0.03% P.=0.13%.

Aqua regia.	Nitric acid.
.10+.03=0.13% P.	0.1292% P.

These results confirm merely the experiments of Stöckmann,* yet I present them to the Society, thinking that they may probably be of some interest to others, engaged in cast iron analyses.

LXII.—Contributions from the Agricultural Laboratory.

BY CHARLES A. GOESSMANN.

1. *Analysis of Onions.*

The following analysis was carried out, under my direction, by Messrs. Charles Wellington and E. B. Bragg. Air-dry onions, without the leaves, were found to consist of:

Water (at 100° to 110° C.)	89.20	per cent.
Dry vegetable matter	10.80	"

and contained the following amounts of—

Nitrogen	0.212	per cent.
Sulphur	0.048	"
Ash	0.436	"

The percentages of the principal constituents of the ash were:

Potassium oxide	38.51	per cent.
Sodium oxide	1.90	"
Calcium oxide	8.20	"
Magnesium oxide	3.65	"
Sesquioxide of iron	0.58	"
Silicic acid	3.33	"
Phosphoric acid	15.80	"

Sulphuric acid not determined.

2. *Urinary Secretions.*

Urinary Calculi.—The concretion was taken, during a *post mortem* examination, from the bladder of a farmer, who had been suffering for two years previous to his death. I found the entire weight of the fresh, yet dry calculi nearly six ounces. The largest specimen was of the size of a small hen's egg; all had a laminated structure. The different layers, which varied in color from white to bluish gray when fresh, separated readily from each other after exposure to the air. An analysis by Mr. John F. Winchester, gave the following results:

One hundred parts of a large sized stone consisted of:

Moisture, organic and volatile matter	41.08	parts.
Ash constituents	58.83	"

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* Fresenius' Zeitschrift für Chemie, 2 Heft, 1877.

The ash contained:

Phosphoric acid	28.02 parts.
Calcium oxide	21.47 "
Magnesium oxide	7.82 "
Carbonic acid	1.50 "

The organic and volatile matter contained:

Nitrogen	2.84 parts,

which was present partly as actual, partly as potential ammonia, namely: 2.73 parts as actual ammonia (= 3.32 parts), and 0.110 parts as potential ammonia (= 0.133 parts). The calculi consisted thus evidently of the following compounds:

Neutral phosphate of lime	30.80 parts.
Ammonia magnesium phosphate	56.88 "
Carbonate of lime	8.54 "
Organic matter and moisture	3.78 "
Total	100

A small quantity of organic matter, containing nitrogen, had served for the cementation of the partly crystallized mineral substances.

The calculi above described, are mainly remarkable for their extraordinary size; as they are of a quite frequent occurrence, as far as their composition is concerned.

3. *Mineral Constituents of Urine.*

In the following lines, I intend to report some analyses regarding the essential mineral constituents of the urine from the cow and horse.

One thousand parts of the fresh urine contained the following quantities of essential mineral constituents:

	Cow.	Horse.
Potassium oxide	17.49	10.74 parts.
Sodium oxide	0.46	0.44 "
Calcium oxide	0.69	1.36 "
Magnesium oxide	0.40	1.87 "
Phosphoric acid	0.10	0.04 "
Sesquioxide of iron	0.10	0.02 "
Silicic acid	not determined	0.29 "

Chlorine and sulphuric acid not determined.

The first stated analysis was made at my request, by Mr. W. P. Brooks, and the second one by Mr. J. F. Winchester.

The cow had been fed with from one to two pounds of Indian meal and one peck of turnips per day, with all the hay wanted; and the horse had received daily from six to eight quarts of Indian meal, and all

the hay wanted. No particular instruction regarding the feeding had been given; nor had any particular part of the day been assigned for collecting the material which served for our examination.

According to E. Wolff, the different kinds of food given contain the following amount of mineral matter:

Hay	6.66 per cent.
Indian meal	1.23 "
Turnips	0.75 "

These mineral constituents contain, on an average, in the case of,

	Hay.	Corn Meal.	Turnips.
Potassium oxide	25.68	26.83	40.00
Sodium oxide	7.06	1.62	10.66
Calcium oxide	11.56	2.44	10.66
Magnesium oxide	4.90	14.62	4.00
Phosphoric acid	6.16	44.00	13.30
Silicic acid	29.58	0.81	2.66
&c.	&c.	&c.	&c.

In comparing the relative proportions of the mineral elements as found in the food consumed, with those found in the above reported two analyses of two samples of urine, we notice at once a striking difference. It is plain that in one case of feeding, the larger portion of alkaline earths, lime and magnesia, and practically the entire amount of phosphoric acid of the food, must have been separated by a different channel than the kidneys. The samples of urine we tested belong to the true type of what is usually considered the normal urine of domesticated herbivorous animals under customary rules of support; both were slightly alkaline and somewhat turbid when fresh collected.

4. *Owasco Gypsum.*

The Owasco gypsum bed, according to a circular on hand, is located on the east bank of the Owasco creek, near Port Byron, Cayuga county, N. Y. A printed analysis states the following composition of the gypsum:

Moisture	5.00 per cent.
Phosphate of lime	7.55 "
Sulphate of lime	60.05 "
Magnesia	14.50 "
Alumina	8.60 "
Silica	3.10 "
Proto-oxide of iron	1.20 "
	100.00

The singular composition, ascribed to a gypsum rock, as well as the peculiar mode of stating the composition of a material recommended for fertilizing purposes, induced me to subject the gypsum to an examination, and to ascertain its value. The material, which served for an analysis was represented as a genuine average sample of the ground rock. The gypsum deposit, judging from specimens on hand, consists partly of dark colored masses of considerable thickness, partly of thin, white layers of a more friable nature; the latter are usually separated from each other by a bluish earthy mass of varying thickness. The ground gypsum, as offered for sale, was apparently a mixture of both kinds of the rock, a fact which accounts for *some* of the differences noticeable between the printed representation of its chemical composition and the results of an analysis, made under my direction, by Mr. G. N. Cullum.

One hundred parts were found to contain, soluble in diluted hydrochloric acid.

Sulphuric acid	22.20	per cent.
Calcium oxide	19.89	"
Magnesium oxide	5.24	"
Sesquioxide of iron and alumina	1.05	"

The unaccounted portion consisted of carbonic acid, organic matter, clay and water. These results prove that the valuable portion of the material tested, consists of—

Gypsum (crystallized)	45.74	per cent.
Carbonate of lime	7.77	"
Carbonate of magnesia	11.00	"

Considering only the amount of sulphate of lime present, the value as a fertilizer of this article is not very great, but the diffusion of a comparatively large quantity of organic matter throughout the dark part, as well as the very friable nature of its white layers, with the admixture of a fine clayish marl, favor, no doubt, its disintegration and solubility, and give it a preference to other purer but harder varieties. At the same time the presence of carbonate of magnesia favors the speedy distribution of the sulphuric acid in the soil, as in the presence of carbonic acid, carbonate of magnesia acts on sulphate of lime, forming carbonate of lime and sulphate of magnesia, which has been found for certain plants to be as good a fertilizer as gypsum.

5. *Composition of Cheese.*

The following analyses were made, at my suggestion, by Mr. E. B. Bragg, for the purpose of ascertaining the relative percentage of fat and casein contained in the articles stated.

	I.	II.	III.	
Fat.....	37.38	18.35	31.66	per cent.
Casein.....	22.13	28.63	25.94	"
Ash constituents.....	3.39	4.64	4.50	"
Water and volatile organic matter.....	37.10	49.18	37.90	"
	100	100	100	

Sample No. 1 was taken from whole milk cheese, made from the milk of the Jersey breed, and kindly procured by Professor Arnold, of Rochester, N. Y., Secretary of the American Dairyman's Association.

Sample No. 2 was sent on, for examination, by E. T. Ellsworth, Esq., of Barre, Mass., and according to statement, manufactured from skimmed milk, with an addition of buttermilk.

Sample No. 3 was kindly furnished, at my solicitation, by H. D. Gardner, Esq., of McLean, N. Y., and represented as a specimen of genuine oleomargarin cheese, and was about ten months old when tested. The analytical results, although secured with great care, have only a comparative value. A good cheese contains usually fat and casein in similar relative proportion as the material which served for its manufacture. Time alters invariably the original composition of the cheese, independent of the variations in moisture.

The question of cheapening the cost of cheese has of late engaged considerable attention. Various propositions have been advanced in this connection; some of them have already been introduced into practice with more or less encouraging prospects of success.

A number of samples of cheese were expressly made, at my suggestion, by Th. P. Root, Esq., of Barre, Mass., for the purpose of ascertaining the composition of the cheese produced from the same quality of milk under similar treatment, after more or less of the cream had been separately collected. For the subsequent detailed statement of the management and the results of the entire operation, I am indebted to Mr. Root. The analyses have been carried out, under my direction, by Messrs. E. B. Bragg and C. S. Howe, assistants in the chemical department of the Massachusetts Agricultural College. The milk, which served for the experiment, was taken from about 40 cows—Grade-Durham—on the 17th, 18th, and the morning of the 19th of October last, to allow the making of the cheeses on the same day. The rennet applied was prepared in the following manner: each rennet was digested for twenty-four hours with one quart of water; the solution being removed, the operation was repeated with two-thirds of the water after salting and rubbing the rennet; both extracts were mixed. One pint of this liquid was added to one thousand pounds of milk; in case of

skim milk, the mass was raised to 78° Fahr., in case of whole milk to 82° Fahr., when, in about from twenty to thirty minutes, the milk begins to set. After keeping it for one hour, or until hard enough to permit cutting, the curd was cut with a knife into small pieces. Subsequently the temperature was raised as high as 98° Fahr., and the mass occasionally worked with the hands to prevent its forming lumps, until it had become quite hard. At this stage of the operation the whey was drawn off; the curd taken into the sinks and salted with four ounces of salt for every one hundred pounds of milk used. The mass was then put in the press and kept there for about 22 hours, when it was removed to the drying-room, where it was kept until it was sold. The drying-room has been held at a temperature from 70° to 80° Fahr. In case of new milk cheese, the temperature has been maintained at 70° Fahr., and in case of the skimmed milk cheese, at from 75° to 80° Fahr. The buttermilk has been put back in each instance of skimmed milk, to serve in the manufacture of the cheese. Five different cheese were manufactured.

Sample No. I.—From whole milk.

Sample No. II.—From milk skimmed after twelve hours standing.

Sample No. III.—From milk skimmed after twenty-four hours standing.

Sample No. IV.—From milk skimmed after thirty-six hours standing.

Sample No. V.—From milk skimmed after forty-eight hours standing.

One hundred parts of the cheese contained:

	I.	II.	III.	IV.	V.
Moisture.....	35.83	37.30	42.24	43.95	45.41
Fat.....	31.34	27.81	23.42	17.67	15.77
Casein.....	26.69	30.37	31.99	33.24	34.94
Nitrogen—total.....	4.27	4.86	5.12	5.32	5.52

The entire amount of nitrogen found in each case has been calculated as casein, which, although somewhat arbitrary, does not alter the practical value of the conclusion we may draw from the comparative consideration of the results. The analyses have been made, as far as practicable, at the same time, about four months after the making of the cheese.

Number of hours the milk has been set before it was skimmed.	Number of pounds of milk used for the experiment.	Number of pounds of curd obtained.	Number of pounds of cheese obtained.	Number of pounds of butter obtained.	Number of pounds of milk used for one pound of cheese.	Number of pounds of milk used for one pound of butter.	Amount of cheese from one hundred pounds of milk.	Amount of butter from one hundred pounds of milk.	Price per pound of the cheese obtained.	Price per pound of the butter obtained.	Total amount of cheese and butter obtained from one hundred pounds of milk, in pounds.
									cents	cents	
..	423	50.	45.5	....	9.29	.....	10.76	....	13.75	...	10.76
12	268	26.	22 5	4.	11.69	65.75	8.56	1.52	12.	38.	10.08
24	423	38.5	35.	8.69	12.09	48.68	8 27	2.05	12.	38.	10.32
36	275	28.	20.	7.44	13.75	36.97	7.27	2.70	10.	38.	9.97
48	389	31.	27.	13.31	14.41	29.22	6.94	3.42	10.	38.	10.36

The products obtained from the milk skimmed after twelve and twenty-four hours standing have proved the most profitable from a commercial standpoint, finding also a more ready sale than the remaining skimmed milk cheese.

AMHERST, MASS., June 13th, 1877.

LXIII.—PROCEEDINGS.

Regular Meeting, Thursday, October 4th, 1877, at 8 o'clock P. M.

AFTER reading the paper of Mr. Casamajor, the meeting was adjourned.

M. ALSBERG, *Recording Secretary.*

LXIV.—ON THE EXISTENCE OF A CONNECTION BETWEEN ELECTRICITY AND THE MOTIONS OF CAMPHOR ON WATER.

BY P. CASAMAJOR.

YOU are doubtless familiar with the singular motions of camphor when placed on the surface of water, which are of such extraordinary nature as to attract the attention of even the most careless observer. Very eminent philosophers have studied these wonderful gyrations, but little has resulted from their labors to explain the cause of this phenomenon. Among those who have worked on the subject we find the great Volta; we also find Venturi, Brugnatelli, Fourcroy, Biot, Matteucci, and Dutrochet. Mr. Charles Tomlinson, who has given great attention to the subject, published, in 1863, a work,* in which he gave a full account of previous labors of eminent physicists and chemists on these motions of camphor, to which he added many interesting experi-

* "Experimental Essays. I. On the Motions of Camphor on the Surface of Water." By Charles Tomlinson. Virtue Brothers & Co. London, 1863.

ments of his own. I cannot do better than advise those, who wish to study the history of the subject, to consult this excellent book.

I find in this work, that in 1748 Romieu communicated to the Royal Society of Montpellier his observations on camphor, in which he advanced the idea that electricity is the cause of these singular motions. Romieu states that camphor does not rotate on the surface of water placed in vessels of iron or copper, but the experiment succeeds very well in those made of glass, sulphur, or resin. He also states that, while camphor is spinning in these vessels, it is arrested if the surface is touched with the finger, with iron or brass wire, or a rod of wood; but glass, sealing-wax, or sulphur cannot arrest these motions.

This idea that the motions of camphor on water are due to electricity has met with the disapprobation of all subsequent observers, among whom may be found the names of men, who are famous in the history of electricity. Notable among those is Alessandro Volta, who made several experiments to show that electricity had nothing to do with these motions.

Now, I propose to show you this evening, that there is an evident connection between electricity and these motions of camphor, and, as Volta and other eminent philosophers are unanimous in asserting, that there is no such connection, I may be allowed to say that in the experimental sciences there is no authority of as much value as a fact, if the fact has been well observed. I propose, therefore, to show you the facts, and you are to be the observers. These facts naturally lead to the conclusion, that the remarkable motions presented by camphor on the surface of water are electrical phenomena. I am not prepared at present to go beyond presenting these facts, and drawing from them, what seems an inevitable conclusion. The phenomena which accompany these motions of camphor are very complex, and they have stubbornly resisted every attempt on my part to bring them under a general theory. I am in the hope, however, that, what I have to present this evening, may serve to elucidate this interesting subject.

Camphor is not the only substance which moves spontaneously on the surface of water. Volta discovered the same property in benzoic and succinic acids. Others have added the stearoptenes of essential oils, the butyrates of soda and potassa, carbolic acid, and citric acid; * even pieces of cork soaked in ether will exhibit the same phenomenon for a short time. Naphthalen is mentioned in some books as possessing the same property, but I have found, that it has not.† These substances,

* Hence, as suggested by Tomlinson, a quick way of distinguishing citric from tartaric acid, which does not possess this property.

† In hydrate of chloral, I have found the same property in a marked degree.

with the exception of the stearoptenes, are heavier than water, and they are with difficulty kept afloat; they are also more soluble, than is quite convenient for the experimenter. As they behave exactly in the same manner as camphor towards electricity, I will confine my remarks to camphor, as I have almost entirely confined my experiments to this substance.

If we throw pieces of camphor in water, they rise to the surface, and, if the conditions are favorable, they will move on the water as if gifted with life. The larger fragments have slower motions than the smaller, which is due to their greater inertia; for if we sprinkle the surface of the water with lycopodium, after the ingenious idea of Mr. Tomlinson, we will find that the currents that set from the larger pieces are stronger, than from the smaller. The mobility of the liquid being greater than that of the larger pieces, the liquid moves away from the camphor. The shapes of the fragments of camphor have a great influence on the rapidity of their motions. A spherical piece will exhibit very little motion, while an elongated piece of the same volume, terminated by two pointed pyramids,* will rotate with the greatest energy.

Very often the conditions, under which the motions take place, do not exist, and camphor remains perfectly quiet on the surface of the water. It has generally been supposed, that when this happened, the surface of the water was covered with a film of dirt—either oil, dust, or something else—which, for some reason, prevented the gyration from taking place. If, however, we keep the same water in a glass for several days, and place in it at different times fragments of the same pieces of camphor, we will sometimes have motions, and at other times not, which points to the conclusion, that these irregularities are independent of the camphor, of the cleanliness of the water surface and of the vessel that holds the water.

In the day time the motions are more apt to take place than after sundown. Also when the weather is bright, or when it storms, than when the sky is cloudy and the air damp, but without any presages of a storm. In many books we find that these motions of camphor on water are due to evaporation, although some add the truthful remark, that this explanation is not satisfactory. When I began these researches, I tried several times to determine these motions by heating the water, but without success; while at other times the camphor spun in a lively manner on the surface of ice-water. Evaporation was clearly not the cause.

* As camphor breaks up very readily while being cut, I have agglomerated it into cylinders by compressing it in a Plattner's ore crusher. Thus compressed it stands handling much better.

At this stage of the matter a gentleman, who is one of our associates, communicated to me an observation, which I have already mentioned, that if fragments of the same piece of camphor are placed, on several successive days, in the same volume of water, sometimes there is motion, and sometimes not. It was suggested at the same time, that perhaps magnetism or electricity had something to do with it.

Rejecting magnetism as improbable, and not being aware at the time of the disapprobation by eminent philosophers, of the existence of any connection between the motions of camphor and electricity, I made the following experiment, which I propose to repeat before you after reading this paper.

Having before me a beaker-glass holding water, on the surface of which small fragments of camphor were dancing with great energy, I rubbed a clean glass rod with flannel, and dipped the rod in the water, when I was surprised to see all the small pieces of camphor suddenly reduced to immobility. This experiment was repeated several times with fresh portions of water and of camphor, and always with the same result. Subsequently the same glass stirrer, rubbed with tin-foil to render it electrically neutral, failed to produce any effect.

In the next place, the same experiment was tried with a piece of vulcanite previously rubbed with flannel, but the motions of the camphor did not stop, and they even appeared to increase in intensity. To test whether this was the case, I was led to stop the motions with a glass rod, and then touch the water with the excited vulcanite. You may judge of my pleasure, when the fragments of camphor began again their their gyrations as the vulcanite touched the water. I afterwards ascertained that a rod of shellac or of sulphur had the same effect as one of vulcanite.

The first deduction I made from this was, that positive electricity stops these motions of camphor, while negative electricity increases their intensity. This deduction, however, was erroneous, as I subsequently found that if, after the motions are stopped by an excited glass rod, it is taken out, wiped dry, and excited again, and dipped in the water; and, if the same operation is repeatedly gone over, the motions recommence, and increase in intensity every time the excited glass rod is placed in the water. I also found, that motions, due to positive electricity, may in their turn be stopped by dipping in the water an excited rod of vulcanite.

This requires a word of caution, as by rubbing glass very little positive electricity is obtained, when compared to the negative electricity which may be had, in the same manner and in the same time, from vulcanite, shellac, or sulphur. This difference requires, that a negatively electrified rod be used with great nicety, as otherwise we bring in con-

tact with the water more negative fluid, than is necessary to neutralize the positive electricity, and, as a consequence, the water becomes at once negatively electrified, and the motions continue without interruption.

When the passage from one kind of electricity to another is very gradual, there always occurs an intermediate stage, at which, if several pieces of camphor are on the water, they coalesce. Afterwards, when the water becomes more decidedly electric, these pieces part company, sometimes in quite a violent manner. A point of great importance to note is, that when the surface of the water is electrically neutral, and pieces of camphor adhere to one another, they remain for a long time without perceptibly diminishing, while, when they are in active motion, they wear away in a much shorter time.

Gentlemen, I do not feel, that I sin against any rule of the strictest logic, when I conclude from the facts, which I have mentioned, that there is a connection between electricity and these motions of camphor As to the cause of these motions, it resides in the camphor itself, and the explanation of the phenomenon must be found in some property possessed by certain substances, of which camphor is the type, by virtue of which water, which has been electrified dissolves them with greater rapidity, than when not electrified. If a piece of camphor is held fast on the surface of the water, and lycopodium is sprinkled over this surface, as was done by Mr. Tomlinson, we will see currents flowing outwardly from the camphor. This may be explained by supposing that the water, holding camphor in solution, has the same electricity as the camphor itself. If the fragments are very small and are free, their great mobility allows them in their turn to be repulsed by the surface of the water, which remains comparatively stationary. When we hold fast on the surface of water a piece of camphor with an irregular outline, we may see, by means of lycopodium, that the currents, flowing outwardly from the camphor, are very uneven in different directions. The inequality of the currents must, when the camphor is set free, determine its motion in a direction opposite to the resultant of these currents.

The inquiry, which now presents itself, relates to the nature of the remarkable property, which enables some organic substances—such as camphor, benzoic acid, and others which I have mentioned—to move on the surface of water, when it is electrified. Dutrochet ascribed these motions to a new force, which he called the *epipolic* force. This amounted to giving up the problem. For my part, although I have endeavored to discover the nature of this property, the results, which I have obtained are as yet too meagre and too contradictory for presentation before this society. I do not despair, however, at some future day, to present you with results worthy of your attention.

LXV.—Proceedings.

Regular Meeting, Thursday, November 1st, 1877.

The meeting was called to order at 8 o'clock P. M., President J. Lawrence Smith in the chair. The minutes of the previous meeting were read and approved.

The following members were elected:

Dr. Hanbury Smith, N. Y.; Ch. Lecompte, Tenafly, N. J.; A. J. Rossi, N. Y.; B. P. Blanpied, Hanover, N. H.

The following were proposed:

As members—Prof. Wm. G. Brown, Knoxville, Tenn.; Prof. C. W. Dabney, Emory, Va.; A. Orth, N. Y.; J. H. Striedinger, N. Y.; Prof. C. E. Wait, Rolla, Mo.

As associates—John J. Holly, N. Y.; R. Deeley, N. Y.; Lear Muzard, Brooklyn; E. de la Chapelle, Brooklyn.

The council reported, that suitable rooms had been found in Fourteenth street, but that they could not be leased unless the society was incorporated.

Dr. Chandler read the law about incorporated societies, and a draft of the proposed incorporation.

Instead of the council, a board of trustees would have to be elected, three-fourths of whom must be residents of New York City.

Dr. Goldmark moved, that the report be received and adopted, and that the members should be notified of the proposed incorporation and consequent change of the by-laws. Carried.

The council recommended the following gentlemen as members of the "Board of Trustees" for the first year: Messrs. Morton, Chandler, Habirshaw, Alsberg, Casamajor, Sherer, Nichols, Endemann, Eastwick, Goldmark, H. Draper, Shapleigh, and Havemeyer. Adopted.

The secretary *pro tem.* announced the death of the Rec. Secretary Dr. J. Walz, whereupon the chair appointed Messrs. Stillwell, Endemann, Alsberg a committee to prepare a notice of Dr. Walz's death, and an address of condolence to the family of the deceased.

The following were appointed a committee to make nominations for officers for 1878:

Messrs. Chandler, Eastwick, Alsberg, Nichols, Endemann.

The committee reports the following nominations to be voted for at the next meeting:

For President:
S. W. JOHNSON.

For Vice-Presidents:

B. SILLIMAN,	G. F. BARKER,
J. C. BOOTH,	P. CASAMAJOR,
H. DRAPER,	C. F. CHANDLER.

For Corresp. Secretary:	*For Record. Secretary:*
H. MORTON.	M. ALSBERG.
For Treasurer:	*For Librarian:*
W. M. HABIRSHAW.	E. WALLER.

For Curators:	*For Comm. on Papers and Publications:*
J. GOLDMARK,	H. ENDEMANN,
O. H. KRAUSE,	W. SHAPLEIGH,
C. PICKHARDT.	A. BEHR.

For Committee on Nominations:

E. P. EASTWICK,	E. R. SQUIBB,
E. D. YOUMANS,	H. C. HAVEMEYER,

C. H. SCHULTZ.

The nominations were unanimously approved.

The resignations of R. Hitchcock and F. Prime, Jr., were accepted.

The death of Mr. Wm. D. Russell was announced.

The secretary stated, that he had received letters of acceptance of membership from all the honorary members, with the exception of Mr. A. Dumas.

Mr. Rossi read the first part of his paper, which called for no discussion. Adjourned.

LXVI.—Proceedings.

Regular Meeting, Thursday, December 6th, 1877.

The meeting was called to order at 8.15 P. M., Vice-President Chandler in the chair. The minutes of the previous meeting were read and approved. The election of officers for 1878 re-

sulted in the almost unanimous confirmation of all the names proposed by the Nominating Committee.

President:
S. W. JOHSON.

Vice-Presidents:

R. SILLIMAN,
J. C. BOOTH,
H. DRAPER,
G. F. BARKER,
P. CASAMAJOR,
C. F. CHANDLER.

Corresponding Secretary:
H. MORTON.

Recording Secretary:
M. ALSBERG.

Treasurer:
W. M. HABIRSHAW.

Librarian:
E. WALLER.

Curators:
J. GOLDMARK,
O. H. KRAUSE,
C. PICKHARDT.

Committee on Papers and Publications:
H. ENDEMANN,
W. SHAPLEIGH,
A. BEHR.

Committee on Nominations:
E. P. EASTWICK,
E. D. YOUMANS,
E. R. SQUIBB,
H. C. HAVEMEYER,
C. H. SCHULTZ.

The Incorporation of the Society, with the consequent change of the By-laws, including the election of a Board of Trustees for 1878, were adopted.

The Committee on Papers and Publications report, that they can make arrangements, by which, at a slight increase of cost, they can secure a more prompt publication of the Proceedings of the Society than could be attained heretofore. They offer the following resolution:

Resolved, That the Committee on Papers and Publications be authorized to print the Proceedings in such manner as they deem best.

Carried.

The following were elected:

As members—Prof. Wm. G. Brown, Knoxville, Tenn.; Prof. C. W. Dabney, Emory, Va.; A. Orth, New York; J. H. Streidinger, New York; Prof. C. E. Wait, Rolla, Mo.

As associates—John J. Holly, New York; R. Deeley, New York; Lear Muzard, Brooklyn; E. de la Chapelle, Brooklyn.

Mr. Rossi read the second part of his paper: Report on a New

Process for the manufacture of Artificial Ice, by means of Anhydrous Sulphurous Oxide. Dr. Goldmark remarked, that the milky appearance of the ice might be due to two causes: to the presence of air as well as to the grouping of the crystals, since milky ice becomes clear by dipping in warm water, and the production of transparent ice from water previously filtered through charcoal might be the consequence of the removal of air from the water.

Mr. Balser showed a centrifugal machine for laboratory purposes run by a single bichromate cell.

The following were proposed as members: Prof. A. R. Leeds, Hoboken, N. J.; Davenport Fisher, New York; L. F. Beckwith, New York; M. S. Thompson, New York; M. G. Waldstein, New York; Wm. T. Lees, New York.

Adjourned.

LXVII.—Report on a New Process for the Manufacture of Artificial Ice.

BY AUGUSTO J. ROSSI, C. E.

An ice machine, producing regularly merchantable ice by a process, introduced in Europe, two years ago, and known as the "Raoul Pictet System, has been in operation for the last five months." This machine, the first built and worked in America, has given very satisfactory results. Its daily production, during a continuous run of five months. day and night, has made this process more than a simple trial, and put beyond doubt its future application to the extensive manufacture of artificial ice in countries where the natural product can only be obtained at a great cost, or not at all. The low cost of production will even allow competition with natural ice, where such ice can be had at a moderate price, as in New York.

A full statement of the peculiarities and principles of this process, with such data or scientific facts as would be necessary for its thorough understanding, might prove interesting.

1. We will consider briefly the different systems, so far used for the production of artificial ice, pointing out the defects inherent to each one.

2. Describe more in detail this new system and the machinery employed, its "*modus operandi*," uses, and advantages.

3. Give such data, as have been obtained during the running of the engine, and the results of such experiments, as we have found advisable to make; also, certain considerations and practical facts, on the differ-

ent appearances of the ice, and their value as far as affecting its properties or qualities.

4. The *resumé*, in a succinct manner, of the scientific problems involved by the working of this machine.

First Part.—Systems hitherto employed for the Manufacture of Artificial Ice.

Ammonia Machines.—These employ, either, saturated solution of ammonia (Carré machine), or liquefied gas ammonia (Tellier machines); they have been described in full in many scientific papers. They are both subject to the same disadvantages. The condensation of gas ammonia at a temperature of 70° or 75°, the ordinary temperature of cooling water, requires a pressure of not less than 10 atmospheres, frequently 15, and consequently a great consumption of coal. Under such pressures the joints are kept tight with difficulty, causing a costly loss of gas. No grease can be used for lubricating the working parts of machinery, owing to its saponification by ammonia. The action of ammonia on copper and on cast iron (owing to the pressure), is another drawback. Beside, the Carré machine is costly, and rather complicated in its details, requiring a careful and difficult management; in this respect the Tellier machine is far preferable.

Ether Machines—Sulphuric or Methylic.—Machines of this kind have the following disadvantages. The low tension of ether, two or three pounds at 27° Fahr., requires the use of a single acting pump working almost under a vacuum. The entrance of air into the working cylinder through the stuffing box, is prevented with difficulty or imperfectly by complicated devices; the ether is oxidized, and the working of the machine impaired. The successive volatilization and condensation of the vapors of ether transform it into isomeric compounds less volatile, affording another cause of trouble. No grease can be used as a lubricator, it being soiuble in ether. Besides, leaks are very dangerous, the vapors of ether being highly inflammable. No insurance companies will take the risks on such establishments; it is also very difficult to obtain a commercial product constant in its properties, excepting at high prices.

Machines worked with Chymogen and other Derivatives of Petroleum.—They have all the disadvantages of the above machines, necessitating the use of a single acting pump working under a vacuum. The difficulties are keeping the joints tight, by the use of water (a very poor arrangement); the difficulty to obtain a constant product, chymogen, being one of the numerous produets of the fractional distillation of petroleum, frequently containing gasoline and rhigoline; and lastly, the high in-

flammability of its vapors, form serious drawbacks to the application of these machines.

Air Machines.—In these machines compressed air is cooled without being allowed to expand, then expanded to its original volume, producducing thereby very intense cold. But owing to the bad conductibility of air (one-quarter that of water), large vessels are required to abstract the heat from it. The joints and valves of the machine have to be absolutely tight, otherwise the working is impaired, and conditions are necessary which are not realized in practice. Owing to the intensity of the cold, glycerine only can be used as a lubricator. The moisture of the air condenses on the inner parts of the engine, thus giving another cause of disorder.

There are numerous other ice machines, but, they are either mechanical contrivances to apply the cold produced by one of the preceding systems, and partake of the disadvantages inherent thereto, or they have never been employed commercially.

One of them however deserves a special mention; its principle being founded on the evaporation of water in vacuo, the vapors being absorbed by sulphuric acid, as fast as they are generated. Mr. Carrè, the inventor, has applied it in Europe, on a small scale, to the freezing of "Carafes." It is evidently limited in its application.

Second Part.—Anhydrous Sulphurous Acid Machines (*Sulphurous Anhydride*).

There is an experiment made in laboratories, which consists in bringing to a red heat a platinum crucible, then introducing a few drops of liquid sulphurous oxide, and simultaneously a few drops of water; instantly there is ice formed in the interior of the crucible, the liquid sulphurous oxide boiling at 14° Fahr. So, the idea of using the liquid sulphurous oxide as a cold producing medium is not a new one in itself, but so far, the difficulty, attending its preparation on a large scale and at a commercial price, had not been overcome. The sulphurous acid liquid must be "anhydrous," on account of the action of SO^2 liquid upon metals in presence of water, it being transformed into sulphuric acid. Mr. Raoul Pictet, by a special patented process, has solved the problem. The construction and principles of these new machines, being based upon the use of the anhydrous sulphurous acid, a brief description of the physical and chemical properties of the oxide will not be superfluous.

The anhydrous sulphurous oxide is a very mobile, colorless liquid. Its specific gravity when liquid, is 1.6, water being 1. Some authors give it at 1 42, Mr. Pictet at 1.6. It has a slightly acid smell, when

coming from the copper carboys, in which it is forwarded from Europe, under a pressure of two to three atmospheres, but it vaporizes almost instantly, producing a very intense cold. Its vaporization can produce a cold of −57° C. in the air. In vacuo, in the presence of alkaline substances designed to absorb the vapors of sulphurous acid as fast as they are produced, the cold reaches −68° C.; at −76° C. it solidifies.

When anhydrous, oxygen has absolutely no action on it, either at the ordinary temperature or on the application of heat.

The easily oxidizable metals, such as zinc and iron, and especially copper, have no action on it at the ordinary temperature. Sulphurous acid, when gaseous, has a sp. gr. of 2.112 (Pictet), air being 1.

Liquid anhydrous sulphurous acid boils at 14° Fahr. under the atmospheric pressure (14.69 lb. sq. in.), its latent heat of evaporation at that temperature, is 170.10 th. U. Its specific heat under constant pressure, is 0,3489.

If in a glass filled with boiling water, a spoonful of the liquid acid be poured, the hot water will be instantly frozen solid.* If a few drops of the liquid are poured on the bulb of a mercury thermometer wrapped in cotton, the mercury solidifies. It has no disorganizing action on animal tissues as the following experiment will prove. If a small quantity of acid is poured in the palm of the hand, an intense sensation of cold is felt, the skin has the appearance of being frozen, and becomes perfectly white, but soon the acid evaporates, and the skin gradually reassumes its normal appearance.*

The carboys, in which it is transported, are copper cylinders, with hemispherical ends, provided with a proper appendage for filling and emptying. Their gross weight is about 330 lbs., and they contain net 200 lbs. of acid, more or less. Their dimensions are one foot diam. × 3′ 3″ long; they are packed in wooden boxes, and no difficulty is experienced with the transportation companies. Being made of stout, strong copper, tested at a pressure much higher than that, at which the acid is compressed in them, they resist perfectly well. The acid being liquid at 14° Fahr. under atmospheric pressure, the excess of pressure in the carboys is mainly due to the rise of the temperature. By keeping them in a moderately cool room, say at 60° to 65° Fahr., the pressure would be from 2 to 3 atmospheres.

The advantages of the anhydrous sulphurous oxide in the manufac-

* Sulphurous acid produces a temporary irritation of the lachrymal glands, which disappears immediately when the cause is removed. The mucous membranes of the throat are more affected. The effect is very similar to that of a catarrh. The odor is strongly penetrating, and causes repeated sneezings. But these effects are temporary, and in the manufacture of this acid no noxious effect on the workmen has been noticed.

ture of ice, are apparent from the above mentioned properties, if we compare it with the other volatile compounds employed; being volatile at 14° Fahr. under the pressure of the atmosphere, the danger of air entering the pneumatic pump is avoided. In a small volume, its specific gravity, liquid, being 1.6 and gaseous 2.112 you obtain an intense cold. At a temperature of 60° Fahr. its tension is only 3¼ atmospheres = 50 lbs.; at 80° to 95° Fahr., 4 to 4½ in the maximum, and at these temperatures and under these pressures it liquefies, while ammonia requires the immense pressures of 10 to 15 atmospheres and more. It is perfectly stable, the most stable of all the compounds of sulphur, and it has no chemical action upon metals.

Brass valves with steel stems used for the aspiration and compression of the gas, heated by said compression to 150° to 200° Fahr., did not show the slightest alterations after five months' use; the inside of the acid cylinder having been examined three times, and being in as smooth and good a condition as if it had never been used. The acid, tested, after its successive evaporations and condensations at the rate of 65 to 70 times per minute, had exactly the same properties as the fresh acid, introduced at start (quite different from ether in this respect).

Besides it is a lubricator in itself, for the piston in the acid cylinder is never greased, while common tallow is used for lubricating the rod and is not affected by the acid. These properties give to the sulphurous acid a great advantage over ether, and all volatile compound derivates from petroleum, like "chymogen," "gasoline," &c. These last compounds, moreover, are inflammable, and it is well known that sulphurous acid not only does not ignite, but will effectually stop combustion.

The cost of sulphurous oxide, delivered in New York, is 65 cents a pound. No doubt, if this new industry develops to a large extent, manufactures of the acid could and would be established in this country.

Description of the Machine.—The apparatus consists essentially of a refrigerator, in which the anhydrous sulphurous oxide is charged; of a pneumatic pump (double acting), receiving its motion directly from a steam engine, or any other motor; of a condenser, to condense the gas to the liquid state; a proper system of pipes to return the liquefied acid to the refrigerator; and of a tank to transmit the cold produced to the water to be congealed.

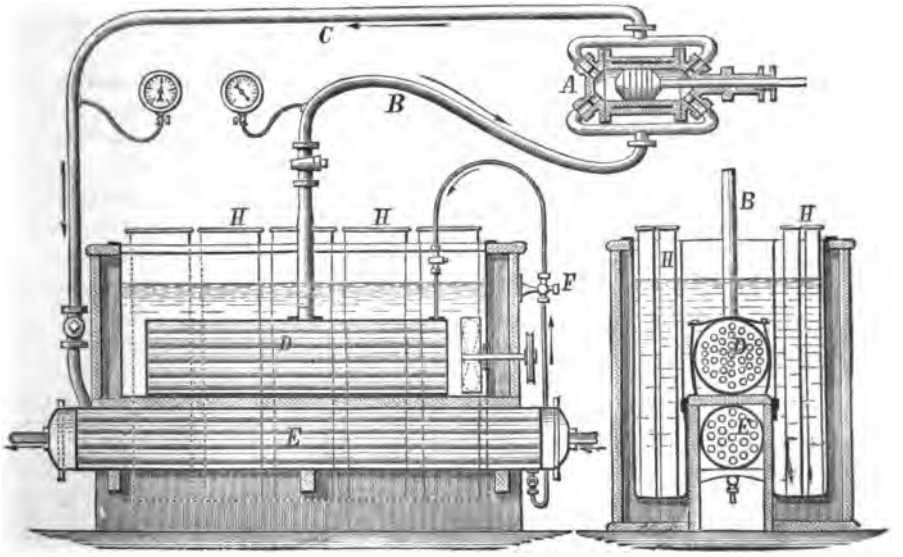
The refrigerator consists of a pair of horizontal copper tubular boilers, connected together at the bottom, and put in communication by means of proper cocks, pipes, fittings and valves, all of copper or brass, with the pneumatic pump. These two tubular boilers are immersed in

a mixture of glycerine and water, at 8° Beaumé, contained in a wrought-iron tank.

The pump is a plain cast-iron cylinder, in which moves a solid piston, fitted with compression rings and springs at each end of the cylinder, and to close it are bolted two valve-chambers to admit the gaseous acid into the cylinder, and to discharge it when compressed. These valve-chambers are fitted with proper cocks and valves of copper, and put in communication with the refrigerator and condenser. The valves are simple steel stem and plate valves, with copper spring coils, and do not weigh over 2 or 3 pounds. The rod of the piston is hollow to allow it to be kept cool when the engine is running, by a proper circulation through it of cold water.

The condenser consists of a pair of copper tubular boilers, exactly similar to the boilers of the refrigerator, with proper fittings and connections with the pump and refrigerator. They are in a vertical or horizontal wrought iron tank, in which cold water is made to circulate freely.

An overflow is provided at the top, and the overflowing water is also used for circulating around the acid pump, so as to cool it during compression. One of the peculiar features of the condenser is the return pipes for the liquid acid. They start from the bottom of the condenser's boilers, rise to the top in the interior, then come out and down vertically to connect with the boilers of the refrigerator, in which they enter, at the upper part. They are provided with regulating cocks, which allow more or less free admission of liquefied gas into the refrigerator.



The steam engine is an ordinary condensing engine, with no peculiar features.

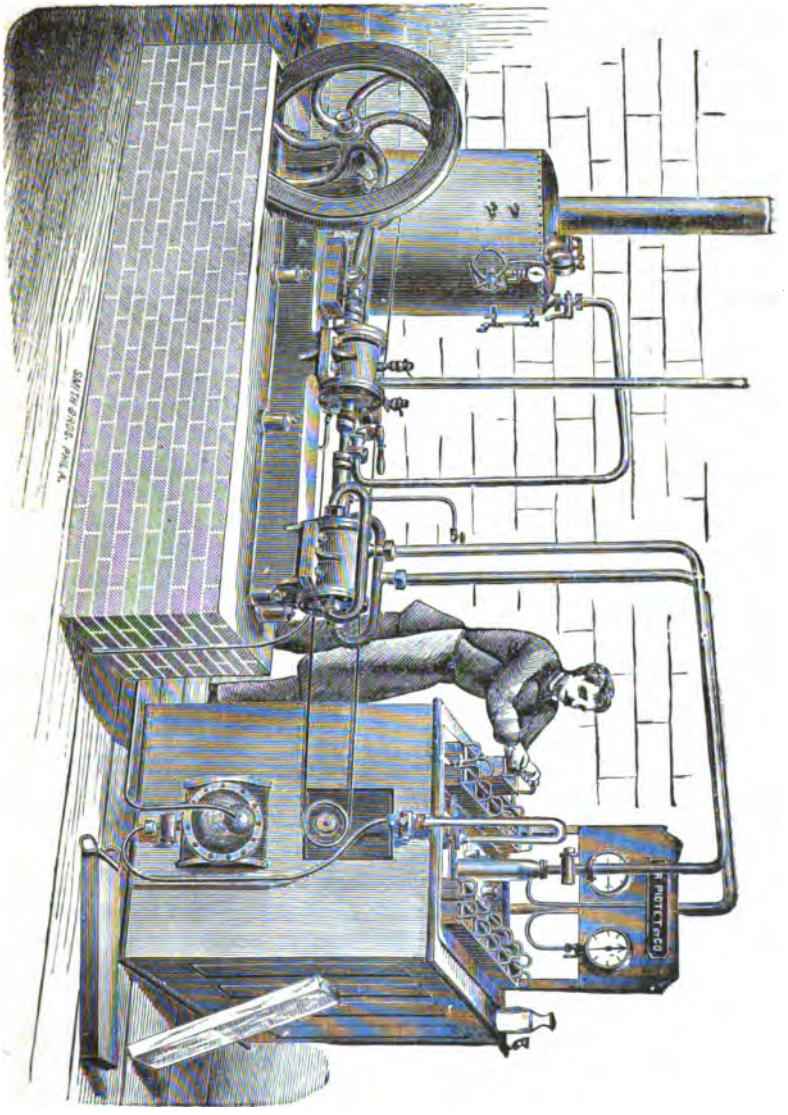
The mixture of glycerine and water, contained in the refrigerator's tank is allowed to flow through a cast-iron pipe at the bottom into a large iron tank, containing also glycerine solution, and divided into compartments by means of solid parallel and vertical partitions, extending down to the bottom, and presenting at each alternate end an opening to allow the flow of liquid to circulate in a zigzag course from one compartment to the other. The liquid is admitted in this large tank at the opposite ends. The two flows circulate from compartment to compartment, and finally unite into a central one, from which they are pumped back by a rotary pump to the refrigerator's tank, flowing first over the surface of the boilers and then through the tubes, before it can discharge again from this tank into the large one, thus producing a constant and rapid circulation.

[To illustrate the system, there is annexed here the cut of a small size machine, producing two or three tons of thin ice daily, and worked on the same principle.]

In the mixture of glycerine and water, contained in the large tank, are placed a number of prismatic boxes of galvanized iron, $12'' \times 6'' \times 3'\,6''$ in which is put the water to be converted into ice. The number of these boxes, and consequently the dimensions of the tank, is so proportioned that the sum of their contents in ice will correspond in 24 hours to a given production.

The operation is conducted as follows:

800 to 850 kg. of anhydrous sulphurous acid are charged, once for all, into the refrigerator's boilers, and the mixture of glycerine and water, or a saturated solution of chloride of sodium, or better, chloride of magnesium—in a word, any mixture capable of standing a cold of 8° or 10° Fahr. without freezing—is poured into the large tank. The liquid assumes a level in this tank and in the tank of the refrigerator, by means of the pipes of communication. All the cans are then filled with water and placed in the large tank, care being taken to have the level of the liquid, before putting in the cans, so calculated that it does not overflow when they are all full and immersed. Then the engine is started. The sulphurous acid at once vaporizes. Its vapors are aspirated by the pneumatic pump, and enter the cylinder, which they fill at a tension corresponding to the point of ebullition; this tension varies from the atmosphere to 3" or 4" below, that is from 14.7 lbs. to 13 lbs. about. On the return stroke, the gas is compressed to $\frac{1}{4}$ or $\frac{1}{5}$ of its original volume, having thereby its temperature raised to 145° to 180° Fahr. The compression valves open, and a certain volume of gas enters the condenser. The flow of cold water carries away the heat,



generated by the compression, bringing the temperature of the flowing water from 54° Fahr. at the inlet to about 61° Fahr. at the outlet. Under the pressure of 3 to 3½ atmospheres (35 lbs. per sq. inch+atmosphere), produced by the compression, the gas repasses to the liquid state, and flows back liquid by means of the small pipes, spoken of be-

fore, to the boilers of the refrigerator, from which it was originally vaporized. The cocks on the return pipes must be so regulated, that the liquid acid flows back at the original pressure in the refrigerator. In the next stroke the same operation is repeated.

Now, each time the liquid acid volatilizes, heat is required for the change of state equal to its latent heat of evaporation, and as there is no other source of heat but the mixture of glycerine and water, circulating around and through the tubes of the boilers, in which it is inclosed, its volatilization brings down the temperature of the liquid at each stroke, and this, evidently, in proportion with the capacity of the acid cylinder. After a time, the temperature of the mixture and that of the water in the boxes, reaches the freezing point of water. Then the water in the boxes begins to cede its latent heat of congelation in passing from the liquid to the solid state, first to the bath, which transmits it to the refrigerator, then to the acid for its volatilization, and the water freezes in the boxes. If the machine was kept running until all the water had been congealed, and if the ice formed was not taken out, the mixture of glycerine and water would ultimately be frozen solid.

When the ice in the boxes is ready, the workmen, by means of a properly constructed crane, moving around an axis in the center of the large tank, and connected with the machinery, take out one box, dip it into hot water to loosen the block of ice. The box is then replenished with fresh water and put in its place in the bath. The next box is then taken out, and so on. The total number of boxes must be properly calculated for a given production in 24 hours, and correspond to a certain number taken out in one hour, so that when the men come to the first can taken out, it must again be ready for them. This number of boxes, of course, is determined by the amount of thermal units, which the machine can absorb for the successive volatilization of the acid during one hour.

The process, as will be seen, is very simple. The pressure in the condenser does not exceed 35 to 37 lbs. per sq. inch+atmosphere, requiring a boiler running at 65 to 70 lbs. of steam and an average absolute pressure in the steam cylinder of 28 to 30 lbs. maximum. No serious leaks are possible under such pressures, except by reason of defects in the machinery. The boilers in the condenser and the refrigerator need not be of excessive thickness. The joints can be and are effectually tight. In the refrigerator, the pressure fluctuates from 14.7 to 12 lbs. Here there is no difficulty in keeping joints tight, and the loss of acid is nominal.

The part of the engine, where a leak is most likely to take place, is the stuffing box of the rod of the acid piston. But this can be effectually prevented by proper care in packing and moderately lubricating the rod by means of common tallow.

The glycerine in the tank scarcely needs renewing if care is taken to wipe the cans, while removing them from the bath, by means of a proper automatic device. However the use of saturated solutions of common salt or chloride of magnesium (preferable because it has no galvanic action on the iron of the boxes), makes this matter a question of very little or no importance, these salts being at a very low price.

The space occupied by the steam engine, machinery, pumps, boilers, foundations for a duplicate engine, tanks, condensers, refrigerators, coal sheds, a small ice house containing 10 tons, and filters for croton water, covers a surface of $40 \times 75 = 3000$ sq. ft. for a production of 24 tons in 24 hours.

Third Part.—Data and Facts.

The temperature of the water (croton water) put in the boxes averaged 75° Fahr.; to bring it to 32° Fahr., 43 thermal units per lb. must be absorbed; to pass into ice, each pound of water will abandon 142 thermal units. In all $142+43 = 185$ thermal units are absorbed per lb. of water at 75° F., when it is converted into ice. Now, 1 lb. of sulphurous acid, having a latent heat of vaporization $=170.1$ thermal units, can absorb 170.1 thermal units, when volatilized, or 1 lb. of acid, by its volatilization, forms theoretically nearly 1 lb. of ice.

The water used in the condenser was well water. Its temperature was 54° Fahr. at the inlet, 61° Fahr. at outlet, the quantity consumed, 150 to 160 gallons per minute. This same water was thereafter used for the condenser of the steam engine and the cooling of the acid pump before being allowed to go to waste.

Should the temperature of the condensing water be higher, say 80° to 90° F., as might be the case in a warm climate, or if croton water had been used for condensing, the machine would have worked quite as well. Only the pressure in the condenser would have been higher, corresponding to the tension of the oxide at that temperature; that is, 4 atm. or 60 lbs., and more coal would have been consumed.

The average horse power from indicator diagrams, taken hourly for several weeks (two months), was found to be 73 to 75. Friction diagrams were taken with the engine running all transmission, pump for condensing water, circulating pump for freezing tank, feed pump for boilers, acid pump with all the valves open, air pump for steam condenser, and they gave 20 horse power, leaving about 50 to 55 horse power as the power necessary for the compression of the gaseous oxide, including friction of gas in aspiration and compression pipes. The number of revolutions of the engine was on an average 60 to 65 per

minute; average steam pressure in boilers, 65 to 70 lbs. The quantity of ice (6″ thick) produced was 16 tons in 24 hours; if the ice had been 3″ thick, 24 tons daily would have been produced.

As it is, reckoning on a 24 tons' production, ice could be manufactured at $1.60 to $1.75 a ton, counting labor, fuel, general expenses, superintendence, &c., and 6 per cent. interest on the capital engaged. taxes, &c.; for a production of 50 tons, $1.30; for 100 tons, $1.25; for 200 tons, less than $1 a ton. The normal pressure in the condenser was 35 to 37 lbs.; in the refrigerator, the atmosphere, or 14.7 lbs. to 13 lbs.; average temperature of the bath, 22° F.; diam. of the acid cylinder, $13\frac{1}{2}$″; stroke, 42″; diam. of rod, $2^{15}/_{16}$″; area piston ($\frac{1}{2}$″ rod deducted), 89″ = 139,605; volume = 5933.21 cub. in.; number of boxes in tank, 628; weight of water in boxes, 5.000 lbs.; weight of mixture of glycerine and water, 36,000 lbs.; total mass of liquid, 86,000 lbs. Dimensions of boxes or moulds, 12″ × 6″ × 3′ 6″ deep; dimensions of cakes of ice, 12″ × 6″ × 3′, weighing 80 to 84 lbs. when full. Temperature of condenser, 62° to 65° F.; refrigerator, 13° to 14° F., which corresponds to a temperature in the freezing bath of 23° F. to 22° F.; temperature of gas after compression, as it enters the condenser, 140° to 180° F. Dimensions of refrigerator boilers. diam. 20″ × 9′ 3″ long; dimensions of condenser boilers, diam. 20″ × 9′ 3″. Number of tubes in each 160 of $\frac{7}{8}$″ diam. inside (1″ outside). Labor required, 4 men and 2 boys, and 2 engineers. This labor would have been adequate to a production of 50 tons daily.

Appearances and Formation of Ice.

Having explained the principal features of the engine and its working, the examination of the ice produced presents some facts (based on actual observation), which may prove interesting.

The cans being filled with water are placed in the bath. In some of the cans the temperature lowers gradually, and in from a $\frac{1}{4}$ to $\frac{1}{2}$ hour after the immersion a thin coating of ice may be noticed on the sides. This coating gradually increases in thickness, the four frozen surfaces proceeding towards each other, and finally closing to a solid cake. This will happen preferably when the bath is at a comparatively low temperature. In other cans, the congelation will be characterized by the formation of long thin needles, pointing from the faces towards the centre of the cake. These needles grow stouter and stouter at their base, as the freezing proceeds, and after a time form a solid mass along the sides of the can, which mass gradually increases in thickness until all the water is congealed.

However, if two such cakes are taken from the tank, when finished, it is impossible to distinguish this difference in the formation. If the

temperature of the bath is below 22° F., the congelation takes place more uniformly in all the cans. In this case it begins by a thin coating on the sides, which increases in thickness until completely frozen; the cakes, when taken out, are uniformly opaque and whitish.

If the bath is at a higher temperature, 24° or 25° F., it is not unusual to find some cans, which, after an hour or more of immersion, do not present the slightest trace of congelation. The water is at a temperature of 28° or 29° F., yet does not freeze. This phenomenon presented by the water is well known "as the surfusion of the ice."

An agitation of the mass will instantly cause the formation of lamellar crystals of ice in a confused mass, intersecting each other in all directions, preventing the bottom of the box being seen. They have the appearance of ferns or arborescences, very similar to the formation of frost on a pane of glass during the winter. Soon after a coating of ice is formed on the sides, and the congelation proceeds as in the cases mentioned above. Frequently, after the cake is solid, these arborescences will be very visible, showing in white in the transparent parts of the cake; but in other cases it will be impossible to detect any difference of appearance in the cakes of ice, whatever may have been the mode of formation.

A constant character, which is easily observed, is, that when the ice is formed at temperatures above 25° F., it is invariably translucid and transparent, the more so the higher the temperature of the bath. On the contrary, if the bath is maintained at a temperature below 20° F. (16 to 18), the ice is more or less opaque and whitish, increasing as the bath lowers in temperature.

The following observation would tend to prove that the causes of these appearances are specially due to the presence of air or gas dissolved or contained in the water.

Croton water, circulating through pipes, with air vents, and coming from large areas, where the air contained in the water has had time to escape, gives always more transparent and more translucid cakes than running water from rivers, or water from wells (especially, if it has been filtered through charcoal filters).

The ice from well water, not filtered, on the contrary, is always more or less opaque and white, if it has not been deprived of air, and the mass is filled with small bubbles of air. In the cakes of ice, formed at a low temperature, or obtained from water, containing a large excess of air (like well water), the air escaping from the water has no time to rise to the surface during the congelation. The formation of ice has been so rapid, or the amount of air so large, that the globules of air have been imprisoned in the mass, filling the whole cake, and producing a diffusion of light, which gives it its milky and whitish

appearance. In a bath at a higher temperature, or with water like the filtered croton water, containing comparatively a small amount of air, the air is mostly found in the center of the cake, in needles radiating at right angles to the faces of the box from the median part of the block. They are thickest at the base; the rest of the cake is perfectly transparent. In cases, where the congelation has been at first very rapid, there will be found, on the outside of the cake, only a thin milky coating. This was the part directly in contact with the metallic sides of the box, and on account of the good conductibility of the metal, the water received, rapidly at first, the action of the bath; afterwards, owing to the slow conductibility of the ice, the air had time to rise to the surface. Sometimes there will be found here and there spherical globules of air of rather large size. They may have been produced by variations of the temperature of the bath during congelation, but the characteristic of the formation of ice at a high temperature is the transparency of the cake. Whatever organic or inorganic matters the water may hold in solution, are found at the bottom and in the central part of the cake like a film. These matters, being mostly white, do not show through the milky part of the center. When the water cools by immersion in the bath, these substances begin to precipitate in mass at the bottom, the water being supersaturated at that temperature, which it reaches; but there is still water enough to hold a part of them in solution, and as the ice forms, they are separated in the center of the cake, forming a pyramid-like film, the apex of which is towards the top of the cake.

If the cake is broken at right angles to its length, the cross-section will show this central film more or less milky, containing some of the impurities of water and most of the air; from this film radiate tubes or needles of air towards the sides, and all the rest of the mass is perfectly translucid.

With well water, not de-aerated, no film is visible, the cake is uniformly milky and solid, and as clean on the bottom as at the top. The same results were obtained with water from rivers of the Island of Cuba, from Cincinnati, Bermudas, Baltimore, Philadelphia. Rain water was tried several times; the cake was frozen at a temperature of about 26° F., and presented a rather milky appearance; but on being broken, the cross-section showed only a thin coating on the outer surface, then a transparent mass, but intersected by zones of very minute, delicate, thin needles of air, pressed closely together, very much like the fine mountain shadings on a topographical map.

Water boiled for a few minutes before being put in the boxes gave a very beautiful transparent cake.

These considerations bring us naturally to the conclusion, that, by

de-aerating water, the ice would be improved. By a special process (patented), which consists of submitting the water to a vacuum before filling the cans, this process increasing the cost of a ton of ice but a few cents (2 or 3), we have obtained remarkably clear and transparent ice. As there is no possibility of making the vacuum absolutely perfect, and notwithstanding the use of a special device to prevent water from dissolving air again during congelation, the water will still contain some air, the central part of the block being slightly opaque.

This opaque center in all cakes, whether the bath is at a high or low temperature, when the water has not been deprived of air, or only imperfectly so, can be explained by the fact that, this portion of the liquid is always saturated with air, at the maximum of saturation, since it is the last remaining liquid.

To get rid of these centers, and to obtain clear and transparent ice, irrespective of the temperature of the bath, Mr. Turettini, of Geneva, forced air through the water during the congelation, so as to produce a constant agitation of the fluid.

The large vesicles of air in their ascensional motion, produced by the compression pump, carry with them all the smaller globules, which otherwise would have adhered to the sides of the ice in formation. We have not applied it on a large scale, but the experiments made by us prove its efficacy beyond doubt.

All the facts tend to show conclusively, that the opacity of the ice is due to the presence of air alone.

Direct experiments made by Mr. Pictet to ascertain the quantity of heat by the calorimeter necessary for the fusion of 1 kg. of ice, either artificial, natural, opaque, milky, or transparent, have failed to show the slightest difference.

The time necessary to freeze one box full of water depends, of course, on the number of such boxes in the tank, capacity of the machine, and on the temperature of the bath.

The thickness of the ice cut also enters as a very important factor. We have made some experiments with a view to ascertain its influence. Holes 10″ deep and 1″ apart were drilled in a block of solid ice, when in the bath. In these holes a thermometer was placed. At 1″ from the sides of the box the temperature observed was 22° F.; at 2″, 27° F.; at 3″, 30° F.; in centre, 31° F.; the bath being 18° F.

This shows conclusively that, owing to the bad conductibility of the ice, the second inch took longer to freeze than the first, the third longer than the second; and that in the center of the cake the water was mostly frozen by actual contact with the ice formed, the influence of the bath being there but slight. This experiment shows also the advantage of making thin cakes of ice. If the cakes had been 3″ × 12″, instead of

$6'' \times 12''$, the machine would have produced 24 tons at least in 24 hours. The machine had been calculated originally on this basis. But the objection was raised that 3″ size cakes would be objectionable for the New York market, so cans of 6″ were employed, thereby causing a fall in the production of the machine.

The consequence of the production of the 6″ thick cakes, instead of 3″, was a lowering in the temperature of the bath to 15° and 14° F. The ice, owing to its thermal resistance, not transmitting the cold to the water not yet frozen in proportion as it received it from the cooling mixture, consequently the temperature of the bath decreased. We suggested the enlargement of the tank, and this being done, an increase in the production resulted. The amount of the cooling liquid being larger with two tanks, the bath instead of keeping at a temperature of 15° or 14° F., was maintained at a uniform temperature of 22° F., rendering available for making ice in *new* cans the difference between 14° and 22°. Of course there is a limit to such an extension of tanks for a given machine.

The radiation through air, the loss of cold by the pipes, the lack of circulation in tanks out of proportion to a calculated size of machine, soon offset the useful effects; and the production of the machine, though increased, could never be reached with 6″ cakes, when its capacity was calculated to 3″ blocks.

Another experiment was made to ascertain, if possible, the form of the curve of congelation. A box filled with fresh water was immersed in the bath, and, after an hour, the thickness of the ice formed on the sides was measured every hour for 20 hours.

On an axis were carried equal intervals of time as abscissæ, and the thicknesses observed were carried as ordinates. By joining the points thus obtained by a continuous line, we have arrived at a fair idea of the curve affected by the congelation.

The curve is not absolutely regular, presenting some points of inflexion. They are due probably to differences in the temperatures of the bath, which varied 21° to 25° F. during the experiments. The difficulties attending these observations are numerous. The ice forms unevenly on the four sides of the box. The faces directly against the current, or along its direction, form ice quicker than the others.

The first hour of immersion must not be counted, as the water in the cans had to be first brought to 32° F. before ice began to form. Only $\frac{1}{10}''$ were formed during the first hour; during the next, $\frac{2}{10}$ in.; making a total, at 12 noon, of $\frac{3}{10}$ in. (for two hours' immersion). Reckoning thickness every four hours, to avoid small fluctuations in the congelation, we find as *total thickness* formed at noon, $\frac{4}{10}$ in.; at 4 P. M., $\frac{5}{10}''$; at 8 P. M., $1\frac{5\cdot5}{10}''$; at 12 midnight, $1\frac{8}{10}''$; at 4 A. M., $1\frac{7\cdot5}{10}''$; at 8 A. M.,

$\frac{154.5}{80}$ in., on the smaller part of the can, counting from the face directly in contact with the freezing mixture towards center of box.

For the large side, at 12 noon, total thickness formed, $\frac{24.5}{80}''$; at 4 P. M., $\frac{92}{80}''$; at 8 P. M., $\frac{120.5}{80}''$; at 12 midnight, $\frac{141}{80}''$; at 4 A. M., $\frac{152}{80}''$; at 8 A. M., $\frac{175}{80}''$, counting also from the face of the can in immediate contact with bath, towards the center of can.

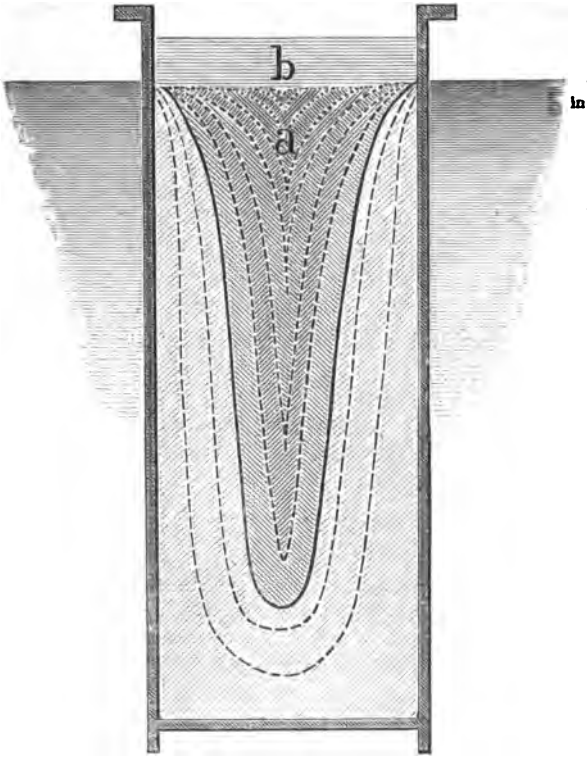
Hence, on small side of can, during the first four hours from noon, there was formed $\frac{5}{8}$ in.; during next four hours, $\frac{20.5}{80}''$; next four hours, $\frac{18.5}{80}''$; next four hours, $\frac{13.5}{80}''$; next four hours, $\frac{9}{80}''$ in. And along large sides, $\frac{51.5}{80}''$ in.; during next four hours, $\frac{28.5}{80}''$; next four hours, $\frac{29.5}{80}''$; next four hours, $\frac{13}{80}''$; next four hours, $\frac{18}{80}''$. Those last sides of the can were in the direction of the flow of the freezing liquid.

These observations cover a sufficiently long interval of time to prove beyond doubt, that the bad conductibility of the ice is a factor of the highest importance in the congelation.

Below are the figures in full:

Dimensions of can 6″ × 12″, the long side in the direction of the flowing of freezing mixture in tank.

Time.	Thickness formed, narrow side, can put in at 75° F.		Thickness formed, widest side.	
	Small size.		Large size.	
10 A. M.	....	....	....	....
11	19/80	.2375	....	....
12 noon	44/80	.5500	34.5/80	.4312
1 P. M.	61.5/80	.7687	....	....
2	75/80	.9375	62.5/80	.7812
3	87.5/80	1.0937	....	....
4	95/80	1.1875	92/80	1.1500
5	102/80	1.2812	....	....
6	106.5/80	1.3312	106/80	1.3250
7	111 5/80	1.3937	....	....
8	115.5/80	1.4375	120.5/80	1.5006
9	121/80	1.5125	....	....
10	125.5/80	1.5687	130.5/80	1.6375
11	130/80	1.6250	....	....
12 midn't	134/80	1.6750	141/80	1.7625
1 A. M.	138/80	1.7250	....	....
2	141/80	1.7625	149.5/80	1.8685
3	145/80	1.8250	....	....
4	147.5/80	1.8437	159/80	1.9875
5	149.5/80	1.8637	....	....
6	152.5/80	1.9062	170/80	2.1250
7	154.5/80	1.9312	....	....
8	156.5/80	1.9562	175/80	2.1875

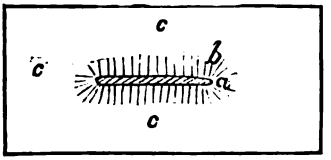


Level of freezing mixture in bath.

V shape formation (a).

Horizontal layers do. (b).

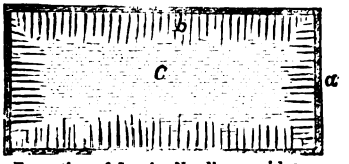
No. 1. Cake Solid.



Regular Formation with Croton Water.

a. Milky part.
b. Needles of air.
c. Transparent parts.
Bath 22° to 26°.

No. 2. Hairbrush Formation.



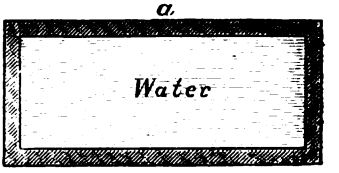
Formation of Ice by Needles on sides.

a. Thin coating on faces of box.
b. Stout thick air needles.
c. Water not frozen.

No. 3.

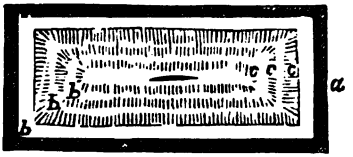
Lamellar formation of ice by arboresences.
Temperature of bath 26° Fahr.

No. 4.

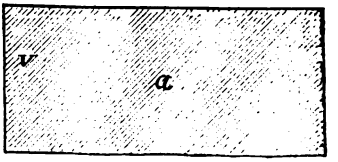


Formation of ice by regular coating on sides of boxes.
Temperature of bath. 18° to 26°.

No. 5.



Appearance of ice formed from rain water.
a. Milky and opaque face.
b. Transparent zone.
c. Minute needles of air.
Cake closed completely in center; no center.



Appearance of ice formed from well water.
a. Uniformly milky and opaque; no center part to speak of. Impurities diffused through the mass.

The measurements are given in inches and decimals. For accuracy, the thicknesses were measured with a rule divided in 80 parts to the inch. As these figures come handy for the plotting of the curve, we give them as we obtained them. For sake of comparison, they are also easier than the decimals of the inch.

It is easy to notice, in plotting the curve, that the interior of the ice, while forming in a can, is of a shape similar to that of the curve. The ice starts from the point zero in the box, corresponding to the level of the freezing mixture in the tanks, and goes on increasing in thickness as we descend in depth. The curve approaches more and more a straight line. The ice appears to form at any moment from the point zero by curves circumscribed by the four sides of the can. The four surfaces thus generated proceed toward each other until the cake is solid.

However, if the cake is taken out from the tank, when the cake is almost, but not quite, frozen to the top, there will be noticed a V shaped hollow at top, formed by the intersection of the four curved surfaces affected by the ice formed. This V is filled with water, with a certain quantity of supernatant fluid raised above it by the expansion of water during congelation. The upper part of this V reaches to the level of the bath in tank 1. If the box is replaced in the bath and allowed to stay in until the water is completely congealed, the V closes, in its turn, by inscribed curves like the rest, but the supernatant water, on the contrary, has a tendency to freeze by horizontal layers perfectly defined and visible. If the can has been so filled with water that the level, after expansion, does not rise above this point, the V closes and no horizontal layers can be noticed.

Fourth Part.—Theoretical Part.

The machines of this system have more than a commercial interest. They have been used by Mr. Pictet to prove practically certain theoretical deductions, establishing certain new relations between the latent heats, the atomic weights, and the tension of vapors of volatile liquids. It would carry us beyond the limits of this article to follow Mr. Pictet at length in his reasonings. He has published a pamphlet on this sub-

ject, under the title, "Application de la théorie Mécanique de la Chaleur à l'étude des liquids Volatils. Geneve, 1876. Archive des Sciences de la Bibliothèque Universelle."

We will confine ourselves to mentioning these relations and to illustrating them by tables. Most of these tables we have recalculated directly in English units, while some we give in French units, as they appear in the pamphlet mentioned above.

We will use freely such of these relations of the reasonings and of Mr. Pictet, as may be necessary for proving the coincidence between the calculations of such machines and their practical working.

1. "For all liquids the cohesion is constant."

This first proposition and the consideration, that the Cycle of Carnot does apply to the volatile liquids and their changes of volume, bring Mr. Pictet to a relation between the latent heats and the pressures of a volatile liquid, corresponding to certain temperature. The formula is the following:

$$\lambda - c\,(t' - t) = \frac{2116.42\,[493.2+(t-32)^2]}{.0807265 \times 493.2 \times \delta \times (t'-t) \times 772}\,\text{hyp.log.}\frac{P'}{P}$$ in English units,

in which t and t' are the temperatures in Fahr. corresponding to the pressures P, P'; λ is the latent heat in thermal units, c the specific heat of the liquid, δ the density of the vapor at 32° Fahr., 0.0807265 lbs. the weight of 1 foot of air at 32° Fahr., 2116.4 the pressure of the atmosphere in lbs. per sq. foot, 772 Joule's equivalent, $\frac{1}{273}$, the coefficient of dilation of gases.

If the latent heats are calculated from this formula, they will be found to agree very nearly with the results of the direct experiments by the calorimeters. By taking for P a constant pressure for all liquids, that of the atmosphere, to correspond to the temperature of ebullition, and in taking in the tables of Regnault, Rankine, or other authors, the pressure P' corresponding to another temperature t'; λ can be calculated.

Liquids.	Temperatures of Ebullition in ° F.	Latent heats λ calculated in th. U.	Latent heats obs'd in th. U.
Alcohol.....	172°.77	378.00	385.29
Sulphide of carbon..	114.80	151.20	150.37
Sulphuric ether.....	95.00	161.22	161.57
Chloroform.....	140.00	109.31	109.80
Benzine	176.00	167.22	166.06
Turpentine	311 00	118.08	122.40
Mercury.....	662.00	128.88	138.00
Hydrochloric ether..	50.00	167.04	165.78
Water.....	212.00	979.8	965.70
Sulphurous oxide...	14.00	179.65	170.10

2. "The internal latent heat L of all liquids referred to one and the the same pressure, multiplied by the atomic weight taken at a uniform temperature gives a constant product."

If we take a uniform pressure for all liquids, that of the atmosphere, it corresponds to a uniform temperature, that of ebullition t, and if x is the weight of the atmosphere at 32° Fahr., its weight at t will be $\frac{x}{493.2+(t-32)}$ and, according to the above proposition $\frac{x\ L}{493.2+(t-32)}$ must be constant for all liquids.

The following table is calculated and based on observations of Mr. Pictet:

LIQUIDS.	Total Latent Heats in Th. Units.	Temperatures of Ebullition t° F.	Atomic Weights x.	External Lat. Heats in Th. Units.	$\frac{x\ L}{493.2+(t-32)}$
Water	965.70	212.	9	72.	11.90
Chloroform	109.80	140.	59	9.56	10.00
Sulphuric ether	161.57	95.	37	14.67	10.00
Acetine	234.00	131.	29	19.87	10.48
Benzine	166.06	176.	39	15.91	9.94
Wood Spirit	475.20	152.6	16	36.86	11.40
Hydrochloric ether	165.78	50.	32	14.40	9.40
Sulphurous oxide	170.10	14.	32	16.05	10.39
Mercury	138.60	662.	100	10.91	11.40
Turpentine	118.08	311.	68	11.52	10.90

3. "For all liquids the difference of internal latent heats at any two temperatures, multiplied by the atomic weight, gives a constant product."

The following tables, based on Mr. Pictet's observations, prove the correctness of this assertion. Considering the difficulty of the experimental determination of the internal latent heats by calorimeter, the coincidence is close:

Liquids.	Internal lat. heats at 212° F. in Th. U.	Internal lat. heats at 230° F. in Th. U.	Differences.	Atomic weights.	Products.
Water	893.32	879.04	14.28	9	128.52
Chloroform	330.48	318.98	11.50	11	126.50
Alcohol	91.85	89.75	2.10	59	123.90
Chloride of carbon.	71.35	69.35	2.00	65	130.00

And for a difference in the temperature of 90° F.:

Liquids.	Internal lat. heats at 212° F. in Th. U.	Internal lat. heats at 302° F. in Th. U.	Differences.	Atomic weights.	Products.
Water.....	893.32	822.06	71.26	9	641.34
Chloroform.....	330.48	277.36	53.12	11	584.30
Alcohol.....	91.85	81.21	10.64	59	627.76
Chloride of carbon.	71.35	60.77	10.58	65	687.70

4. "The derivate of the Napierian logarithm of the ratio between tensions of vapors and temperatures is constant for all liquids, when they are compared under the same circumstances of pressure and temperature."

This ratio is $\frac{\text{hyp. log.}\frac{P'}{P}}{t'-t}$ Now, if values of t' are taken nearer and nearer to t, P' converges towards P, and $t'-t$ towards 0, and the above expression becomes, for $t'-t$, the derivate of the pressure expressed in function of the temperature. If we take for P, a constant pressure for all liquids, that of the atmosphere, t corresponds to the temperature of ebullition; and to find the value of this derivate, it is necessary to differentiate the equation of the pressure expressed in terms of the temperature for $t'=t$.

The following table, expressed in French units, is taken from the pamphlet above referred to. It may be noticed, by looking at the figures expressing the value of this derivate, for $t'=t$ and P=the atmospheric pressure, that this derivate Δ increases with the volatile power of the liquids, consequently, as Mr. Pictet remarks, it can be represented for all liquids by a factor increasing with the volatile power, multiplied by a certain quantity K to be determined for each liquid:

We can then write logically

$$\text{derivate } \frac{\text{hyp. log.}\frac{P'}{P}}{t'-t} = \Delta = K \times \frac{493.2}{493.2+(t-32)}$$

$$\text{In French units, } \Delta = K \times \frac{274}{274+t}$$

The factor multiplying K increases with the volatile power, for if the liquid is more volatile, t, the temperature of ebullition is lower, $(t-32)$ becomes smaller, the denominator $493.2 + (t-32)$ diminishes, and the value of the fraction increases. If, from this formula, K is calculated, knowing Δ, from the table, the values thus found are almost identically the same for liquids as widely different as mercury and sulphurous oxide. Hence the 4th proposition of Mr. Pictet: "The derivate of the Napierian logarithm," &c.

Liquids.	Latent heats in French calories.	Temperatures of ebullition, C. therm'ter.	Derivates Δ.	Values of K.
Alcohol	210.	78.21	.0325	.042
Water	533.9	100.	.0346	.045
Sulphide of carbon	84.0	46.	.03189	.039
Sulphuric ether	90.12	35.	.03563	.040
Chloroform	60.73	60.	.03337	.040
Benzine	92.9	80.	.03000	.040
Hydrochloric ether	92.8	10.	.03779	.040
Spirit of turpentine	65.6	155.	.0261	.040
Mercury	71.6	350.	.02040	.044
Sulphurous anhydride	94.2	— 10.	.04374	.041

Comparing these results with the laws of Dulong and Petit, as to the specific heats, Mr. Pictet concludes further, that:

5. "The latent heats of all liquids are multiples of their specific heats."

We pass now to the theoretical examination of the system.

We have a reservoir or refrigerator R, containing the sulphurous oxide. A pump P aspirates the vapors generated at the pressure P, the atmospheric pressure, at the temperature t (temperature of ebullition), and compresses them into a condenser C′, at a temperature t′, under a pressure P′. Under that pressure P′, corresponding to the temperature t′, produced by a circulation of cold water, the gas repasses to the liquid state again, and is brought back by a proper pipe to the refrigerator R, at the original pressure P, to be volatilized anew.

We can calculate, knowing P t and P′ t′, the horse power necessary to obtain the compression of the vapors from P to P′.

The heat abstracted in refrigerator R by the volatilization of the liquid, *minus* whatever heat may be brought back by the return of the liquid from condenser from the temperature t′ to the temperature t of refrigerator.

These two quantities representing one a number of foot pounds, the other of thermal units, have *a priori* no relation together. It is only by applying the relations established above by Mr. Pictet, that a formula has been found connecting them (formula given above), and it is by comparison of the results, thus obtained, by a machine of this system, that a practical confirmation of the theory has been obtained.

After the compression, the volume of gas, which has filled the pump, is discharged in the condenser under a pressure P′. This pressure is the result of the work of the pump, and the heat generated during the compression of the vapors from P to P′ is carried away by the circula-

tion of cold water in the condenser. Under that pressure P′, and at the temperature t′, produced by the cooling effect of the water, the gas repasses to the liquid state, abandoning to the water its latent heat of vaporization. Hence, in the water flowing out from the condenser, must be found the heat corresponding to the horse power of the engine, either as excess of temperature of the gas above t′ (excess resulting from compression), or as pressure P′, *plus* the heat resulting from the latent heat of liquefaction of the gas. But, as by means of the return pipe to refrigerator, there comes back into the refrigerator, a weight of liquid, precisely equal to that weight, which has entered the pump in the gaseous state, been compressed and afterwards condensed, in the reverse passage of the volatile liquid in the refrigerator from the liquid to the gaseous state, there will be required, this time at the expense of the freezing mixture and of the water in the cans, available to make ice, an absorption of heat equal to that latent heat ceded to the water in the condenser, *minus*, of course, whatever excess of heat may be brought back by the liquid in returning to the temperature t.

Hence, an approximate value of this amount of heat, available to make ice, will be found by subtracting from the total amount of heat, carried away by the condensing water, the thermal equivalent of the horse power, necessary to produce the compression. This disposes of an objection which has been raised by some engineers, that the amount of ice produced by the machine could only correspond to the thermal equivalent of the horse power consumed to produce the compression. The following figures will illustrate it.

There was in the refrigerator tank and freezing tank, when the engine was first started, 24,000 lbs. of glycerine and water, 8,000 lbs. glycerine, 16,000 lbs. of water, and 30,000 lbs. of water in cans, in all 54,000 lbs. of liquid; the whole mass being at a temperature of 78° F. At 4 P. M., on the day of observations, the thermometer stood at 48° F., and 6 P. M. at 28¼° F. Hence, in two hours the temperature of the liquid mass fell 19°.50 or 9°.75 per hour. Consequently in 1 hour 54,000 lbs. of water (neglecting the specific heat of glycerine) were cooled 9°.75, corresponding to 526,500 thermal units, absorbed for the volatilization of the oxide in refrigerator and theoretically available to make ice.

On the other hand, there was passing into the condenser from actual measurement 160 gallons per minute=9,600 gallons per hour.

9600×8.34 lbs. = 80064 lbs. water per hour; the temperature of water at inlet was 53¼° F., and at outlet 61¾° F.; difference, 8½° F. Heat absorbed by the condensing water per hour, 80064 × 8.5=680544 th. U. The horse power, consumed by the pump at the time of experiments, was, from indicator diagrams, 54.75 HP to 55 HP on an aver-

age, the balance of the total horse power of engine being applied to pumping water into the condenser, for air pump of steam engine, friction, &c.

1 horse power = 33000 ft. lbs. per minute = $33000 \times 60 = 1980000$ ft. lbs. per hour; 772 ft. lbs. = 1 thermal unit. Hence, 1 horse power = 2565 thermal units; $55 \times 2565 = 141075$ thermal units; 680544 — 141075 = 539469 thermal units found in condenser; 526500 thermal units were found in refrigerator: the coincidence is close. Reckoning as the *total horse power* of the engine, about 75 horse power, it would give only 192300 thermal units against 526500. The objection is not sustained by the facts. This amount of thermal units, 141075, would correspond to about 8½ tons of ice at 32° Fahr., and we obtained 16 tons at an average temperature of 20° to 21° Fahr.

Let us now calculate the work of the pump for 1 lb. of liquid. We suppose the gas to compressed isothermally, it is sufficiently correct for our examination. Then it does follow the hyperbolic ratio, and the amount of work required to reduce a given volume V of gas at pressure P to a smaller volume, corresponding to a given superior pressure P′, and to force it into a reservoir at that pressure, is in terms of the inital work:

$$\text{T ft. lbs.} = \text{PV}\left(1 + \text{hyp.log.}\frac{\text{P}'}{\text{P}}\right)$$

V initial volume at t° Fahr., at the pressure P of refrigerator = (atmosphere pressure) P′ final pressure in condenser; 2116.4 lbs. pressure of atmosphere in lbs. per sq. foot.

$$\text{V} = \text{Vo}\,(1 + k)\,(t - 32)$$

$$\text{V} = \text{Vo}\left[\frac{403.2 + (t - 32)}{493.2}\right]$$

$$k = \frac{1}{493.2}$$ We make the calculation for 1 lb.

Now, 1 ft. of air at 32° Fahr. weighs 0.0807265 lbs. Let δ be the specific gravity of the gas at 32° Fahr.

1 ft. sulphurous oxide in gas at 32° Fahr. weighs $.0807265 \times \delta$, and 1 lb. occupies a volume at 32° Fahr. of

$$\frac{1}{.0807265 \times \delta}$$ at t° of $$\frac{493.2 + (t - 32)}{.0807265 \times \delta \times 493.2}$$ Hence, for 1 lb.

$$\text{T ft. lbs.} = \frac{2116.4\,[493.2 + (t - 32)]\,[\text{hyp.log}\frac{\text{P}'}{\text{P}} + 1]}{.0807265 \times \delta \times 493.2} \text{ for 1 lb.} \quad (1)$$

The heat absorbed in refrigerator per lb. of oxide volatilized is evidently $Q = \lambda - c\,(t' - t)$ λ being the latent heat of sulphurous oxide in thermal units, c its specific heat, under constant pressure, and t′ and t the temperatures of condenser and refrigerator. We have there all the elements of our calculation.

This machine, when first built, was calculated by the engineer on a basis of 25 tons net in 24 hours. Ice being intended and understood to be 3″ thick, the size of ice manufactured in Paris. Objections were raised against this thickness, as not being merchantable in New York, and 6″ thick cakes were substituted. The consequence was a falling off in the expected production. Owing to the bad conductibility of the ice, a point discussed in another part of this paper, while speaking of the formation of ice, the heat required in the refrigerator for the volatilization of the oxide, was absorbed at the expense of the bath of glycerine and water, which reached a very low temperature, and at that of the ice formed, which showed, in the experiments quoted above, as low an average temperature as 23° F., instead of this cold being applied to freeze fresh quantities of water at 32° F. In a comparison of the theoretical with the practical results, water should be only brought to 32° F., and then, the latent heat of fusion having been absorbed, transformed into ice at 32° F. If the ice goes down in temperature, as was the case on account of the causes mentioned, the real theoretical production of cold, or rather the heat absorbed in the refrigerator for the volatilization of oxide, could only be ascertained by adding to the amount of ice, actually produced at a certain temperature, the equivalent of the difference between this temperature and 32° F., and the excess of cold contained in the bath, beyond what may be called the working temperature. That this assertion is correct, is corroborated by the fact, that direct experiments showed in the refrigerator the absorption of 526,500 thermal units per hour, which, at, say, 200 thermal units necessary to transform 1 lb. of water (at 78° F.) into ice at 32° F., would give a production of over 30 tons in 24 hours.

A direct experiment was made with a can 3″ wide. Ice was formed solid in 3½ hours on an average, the cake weighing 12½ lbs.

One large cake, 6″ thick, weighs at least 75 lbs. Six of the small cans would be equivalent to one large one, but the ice of 6″, under the same conditions of freezing as the ice 3″ thick, had not the thickness which might be inferred.

The time of freezing would have been directly proportional to the weight of ice to be formed, and 75 lbs. would have been frozen in 6×3.5 hours=21 hours. As there were 628 of these large cans in the tank, $75 \times 628 = 46{,}800$ lbs. would have been frozen in 21 hours, corresponding to 53,600 lbs. or 26.8 tons in 24 hours. Actually the 628 cans were frozen in 35 to 36 hours, corresponding to about 16 tons within 24 hours. Practice alone teaches the allowance to be made in such cases. There were for this machine other causes of loss resulting from mechanical arrangements, and which could have been remedied.

In a machine producing thin cakes, the temperature of the ice formed

is little below 32° F. Heat is rapidly absorbed from the water for the volatilization of the oxide, and the working is more in conformity with the requirements of theory. We have said that a too low temperature in the bath was not desirable. This is due to the fact, constant for all machines producing cold, that the production of cold is greater when the volatile liquid is at, or nearly at, the temperature of ebullition, than when it is at a lower temperature. If the temperature goes below this point in the refrigerator, the gas aspirated in the pump is less dense. A temperature of 14° F. (point of ebullition of sulphurous oxide), in the refrigerator about corresponds to a temperature of 23° F. in the bath.

Let us, then, take 25 tons net of 3 inches as the basis, on which really the machine was calculated. To this an allowance of about 8% must be made for loss of ice by immersion in hot water to loosen it from the cans (a quantity which could very readily be diminished by proper arrangements). This gives 27 tons in tank to obtain the net 25 tons in ice house. The water, when experiments were made, was at 79° F. Now, each pound of water, at 79° F., to reach 32° F., requires the absorption of 79−32=47 thermal units, and to pass into the state of ice at 32° F., the absorption of 142.3 thermal units additional (latent heat of fusion), in all, 189.3 thermal units, to be absorbed in the refrigerator by the volatilization of the oxide per pound of water. 27 tons in 24 hours give per hour $\frac{54000}{24}$=2250 lbs. of water to be frozen; consequently, 2250× 189.3 thermal units per hour to be absorbed in refrigerator=Q=425925 thermal units, and per minute $\frac{425925}{60}$=7098.8 thermal units.

Let p be the weight of oxide volatilized per minute.

$$Q = 7098.8 = [\lambda - c(t' - t)] \times p \text{ lbs.}$$

λ latent heat of vaporization of sulphurous oxide = 170.10 th. u. per lb.
c specific heat under constant pressure = 0.35.
t′ temperature condenser = 65° F. t temperature refrigerator = 13°.5 F.
P pressure in refrigerator = from gauge at pump, 13 lbs.
In refrigerator by gauge 1½ = 14.00 lbs. (showing a loss of 1 lb. by friction in pipes.)
P′ pressure in condenser by gauge, 38 lbs. 75+14.72 atmos. = 53.47 lbs. total.

$$7098.8 = p\,[170.10 - 0.35\,(65 - 13.5)] = p\,(170.10 - 18.02) = 152.08 \times p.$$

$$p = 46.68 \text{ lbs.}$$

Introducing this value of p in the equation of the work of the pump (1), we have

$$\text{T ft. lbs.} = p\left[\frac{2116.4(493.2+(t-32))}{.0807265 \times \delta \times 493.2}\right] \times \left[1 + \text{hyp.log.}\frac{P'}{P}\right]$$

$$\frac{P'}{P} = \frac{53.47}{13} = 4.113. \qquad \delta = 2.116.$$

hyp. log. 4.113 = com. log. 4.113 × hyp. log. 10 = com. log. 4.113 × 2.3026.

$\therefore$ T ft. lbs. per minute = $40.68 \times 12913.8 \times 2.42$.

T = 1458820 ft. lbs. per minute.

1 horse power = 33000 ft. lbs. per minute.

T = 44.27 horse power.

At the time the experiments were made, the number of revolutions of engine was 60 per minute, and the horse power, by diagram, 74.87 horse power. Deducting the horse power necessary for transmission pumping, &c., taken from friction diagrams, this would leave for the work of pump, 54.87 horse power, counting 10 per cent. for the slip of the pump, this gives 49.39 horse power. Found by formula, 44.27.

If we make the same calculations, reckoning as the maximum 526,500 th. units found in refrigerator in one of the experiments, we come to

T = 54.35 horse power.

Other experiments made at different times and at different temperatures in the refrigerator, showed an absorption of heat from 500,000 to 530,000 thermal units per hour.

In practice sufficient allowances must be made in the horse power required, capacity of tanks and pumps, for circumstances, such as thickness of ice required by the trade, loss by radiation in tanks and pipes.

In calculating such machines, attention must be given to these questions. Experience alone can teach their importance and value. We have tried, in another part, to examine their influence on the production. What we intended to prove was, that the theoretically calculated horse power corresponding to the heat absorbed in refrigerator (if not to the quantity of ice actually taken out), agrees with the horse power really consumed in practice by the pump, a coincidence, which proves the soundness of the principles, on which this system is based.

A run of five months in the conditions of a maintained commercial production, proves, that the properties of the oxide are not modified by its successive volatilization and condensation, and the simplicity of the mechanism and other advantages, resulting from the chemical and physical properties of the cold-producing agent, authorize us to say that this system can be classed amongst the most economical for the production of artificial ice.

We will only mention its numerous applications to the cooling of air or liquids for technical purposes, such as for breweries, cold storages, chemical works, cooling of buildings, preservation of meats on board of steamers or cars. We have tried to collect and present practical facts from our own observations and experiments, and give a resumé of the principal scientific questions involved in the running of such machines, quoting freely, and textually sometimes, from such a competent an authority as the inventor himself.

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W. B. Rising

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THE AMERICAN CHEMICAL SOCIETY.

I.—Proceedings.

Regular Meeting, January 3d, 1878.

The meeting was called to order at 8.15 P. M., Vice-President Chandler in the chair.

The minutes of the previous meeting were read and approved.

The Committee on Papers and Publications announced, that they had made arrangements with Messrs. Baker & Godwin for the publication of the proceedings.

The following members were elected: Prof. Leeds, Hoboken, N. J.; Wm. T. Lees, New York; M. E. Waldstein, New York; M. S. Thompson, New York; L. F. Beckwith, New York; Prof. D. Fisher, New York.

The following were proposed as members: Dr. von Gehren, New York; Dr. H. J. Schmitz, Leroy, N. Y.; J. Tschermac, Paris; A. L. Thompson, Berlin.

Prof. Leeds read a paper on a new method for estimating nitrates in potable waters.

Adjourned.

M. ALSBERG,
Recording Secretary.

II.—Contributions from the Laboratory of the Stevens Institute of Technology.

BY ALBERT R. LEEDS.

WATER ANALYSIS.

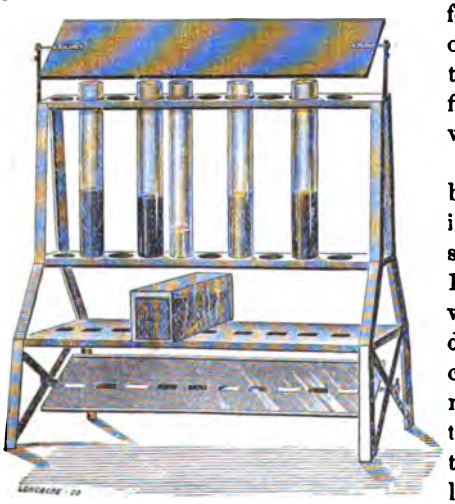
1. *Distilled Water employed.*—Distilled water frequently contains a much larger amount of ammonia than the natural water to be tested. The water of the Passaic, according to the mean of nine determinations made during the months of October and November, 1877, contained in

100,000 parts 0.0033 parts of ammonia; distilled water, condensed in a still, connected with a system of steam coils and a boiler fed with the Passaic water, containing 14 times this amount of ammonia, or 0.45 parts. In determination of the nitrates, distilled water free from ammonia is essential, but in the performance of the Nessler tests, except in the previous preparation of the standard ammonia solution, it is not. Ordinary distilled water is boiled with a gramme or two of potash, until it ceases to give a reaction with the Nessler reagent, and used in making the tests. Sodium carbonate cannot be used, since it would affect the reagent, but the presence of potash is advantageous rather than otherwise.

2. *Preparation of the Nessler Reagent.*—The following will be found more convenient than the directions usually given.

Dissolve 25 grms. of potassium iodide in 100 c.c. of water, and add a cold concentrated solution of corrosive sublimate, until a slight permanent precipitate is formed. Add 50 grms. of potash, make up the volume to 250 c.c., allow to settle and decant upon an asbestos filter. A large amount of mercuric carbonate is formed from the carbonate present in the potassium iodide manufactured in this country, and is thus readily filtered out.

3. *Color-comparator used in Nesslerizing, etc.*—In obtaining by comparison with solutions containing known amounts of ammonia, the percentages of ammonia in the successive distillates, a considerable expenditure of time is requisite, and fresh comparison liquids are requisite for each analysis. In order to obviate this loss of time and trouble, the *color-comparator*, figured in the accompanying wood-cut, has been devised.



COLOR-COMPARATOR.

It is a rack, made of sheet brass or tin-plate, about 16 inches wide and of about the same height. It is made to hold 10 comparison tubes, each of which, when filled to the same depth (6 inches), contains precisely 100 c.c. A movable mirror, 4 inches wide, reflects the light downward, through these comparison tubes, and the light, after passing through slits ($\frac{3}{4}$ inch long and $\frac{1}{4}$ inch wide), cut in a stage beneath, is reflected outward to the eye by a similar

movable mirror. The comparison is effected by a prism which rests upon this stage, and is moved out or in. Not having a solid bottle prism, this prism was constructed after a design of President Morton's, by cementing within four walls of plate glass the top and bottom sides of the prism. The prism is filled through a hole in the forward end, which is afterwards sealed. It is 10 inches long and 2½ inches broad at the base.

Some difficulty was experienced in finding a comparison liquid which would follow the tints given by the Nessler test, both in very dilute and more concentrated solutions of ammonia. It was found that neutral ferric chloride, potassium sulphocyanide and nickel chloride, in proper proportions, gave identical tints, but the solution decomposed on keeping. After many trials, in which the chlorides of gold and platinum and other salts were employed, with the admixture of coloring matters, and of similar mixtures with infusions of tea, coffee, &c., we finally succeeded in obtaining, with caramel solution and a small addition of aniline red, a satisfactory comparison liquid. Above the prism, in the comparator, a comparison tube with distilled water is placed. The comparison liquid is made of such strength, that the light, after traversing its greatest depth in the prism, shall give a tint corresponding to 10 centimilligrammes of ammonia. An application scale is prepared once for all, by comparing the tints given by the prism with those given by known solutions of ammonia and the Nessler test, in 100 or 50 c.c. of distilled water placed in the comparison tubes. The readings are accurate within 0.005 milligramme of ammonia.

Precautions in Nesslerizing.—It became of importance to determine whether a sample of water gave the same percentage of ammonia and albuminoid ammonia, when analyzed a second time after the lapse of an interval. It was found that a sample of the Passaic water, collected November 12th, contained in 100,000 parts 0.002 parts of ammonia and 0 012 parts of albuminoid ammonia, and the same sample analyzed November 16th, contained 0.002 parts of the former and 0.0127 of the latter, showing that in this case at least no change had occurred.

To see whether the distillates lost ammonia on standing, they were Nesslerized after standing 12 hours, and were found not to have lost. The use of a drop of hydrochloric acid, which had previously been added in such cases, was therefore discontinued.

Determination of Chlorine.—It was found that the percentage of chlorine, as determined in the Passaic water, which is slightly colored, by the ordinary volumetric method, using potassium chromate as an indicator, differs from that obtained by the gravimetric method, and that in very accurate determinations, or where the chlorine present in drinking waters of various localities is to be compared, the gravimetric

method is preferable. Thus, 2000 c.c. of Passaic water (sample collected November 26th), evaporated to dryness, a little lime water added at the last to destroy organic matter, gave 0.0239 grm. AgCl, corresponding to 0.295 parts Cl in 100,000; 1500 c.c., same sample treated similarly, gave 0.0178 grm. AgCl, corresponding to 0.293 parts. Two separate portions, each of 50 c.c., same sample, gave on titration 0.26 and 0.25 parts. It will be noted that the percentages by titration are lower than those by precipitation. It was found that the addition of alkaline carbonate to a solution of sodium chloride of known strength did not influence the readings, potassium chromate being the indicator. From this result it would appear that the above discrepancy is not due to the presence of salts other than the chloride in natural waters, but more probably to their slight color, which would operate to make it appear that the end-reaction had been arrived at before such was actually the case. This view derives support from the results arrived at in the following experiment:

500 c.c. of Passaic water, evaporated to dryness, with slight excess of lime water, the residue dissolved hot, brought to 250 c.c., and filtered:

50 c.c. = 1.03 c.c. silver solution, corresponding to	0.26	pts.	Cl	in	100,000.
50 c.c. = 1.00 c.c. " " "	0.25	"	"	"	"
50 c.c. same water in original condition,	0.22	"	"	"	"
50 c.c. " " " " "	0.20	"	"	"	"

Here the ratio between the chlorine percentage, as determined by titration in the water in its original condition, and after the coloring matter had undergone destruction, is the same as the ratio between the chlorine percentage as determined by titration and by the ordinary gravimetric method. The conclusion is, that in the titration of waters at all colored, the organic matter must be destroyed beforehand, in order to secure the most accurate results.

Method of Chlorine Estimation.—The standard silver nitrate solution is prepared by dissolving 1.198 grm. of the carefully prepared dry salt, and making up the volume to one litre, so that 1 c.c. is equivalent to 0.25 mgrm. of chlorine. The potassium chromate solution is prepared by saturating 100 c.c. of distilled water with the neutral salt, and diluting to 200 c.c. The estimation of the chlorine contained in the indicator must in no case be omitted. To this end, one of the comparison tubes, such as employed in Nesslerizing, is filled up to the 50 c.c. mark with distilled water, and 1 c.c. of the potassium chromate solution added from a 1 c.c. pipette. The silver solution is then run in, a bulb stirrer being used until a permanent red coloration is reached, and the fraction of a cubic centimetre noted. This amount, determined with great care,

is to be subtracted from that obtained when the natural water is titrated. Another comparison tube, filled to the 50 c.c. mark, and 1 c.c. of the indicator added, is titrated in like manner. Half the result, corrected as above, gives the amount of chlorine in parts per 100,000.*

When the waters are at all colored, and it is desirable to approach as nearly the accuracy of the gravimetric method, as this method of titration is capable, evaporate 500 c.c. to dryness, with slight excess (about 1 c.c. is usually sufficient) of lime water. These evaporations are very quickly performed when a platinum basin, with a suitable rose burner, is employed. Heat the residue to low redness, treat with hot water, filter, make up the volume to 100 c.c., and titrate in two separate portions of 50 c.c. each. The lime water employed should be expressly prepared, by converting pure marble into caustic lime in a platinum crucible.

Estimation of Chlorine after Distillation.—If it were possible, by distilling a considerable volume of natural water with a large excess of acid, to drive off all chlorine in the first portions of distillates, these difficulties would be more than surmounted. To 600 c.c. of aq. dist. 10 c.c. of a solution containing 1.1633 grms. NaCl in one litre were added, and also 50 c.c. sulphuric acid. The first six distillates of 50 c.c. each contained no chlorine, the five following indicated chlorine in increasing quantities.

The method therefore is not feasible.

Estimation of Nitrates.—The apparatus recommended by Prof. Thorpe in his original article was employed, except that a Wolff's safety tube was found more convenient than a thistle tube with glass stopcock, to introduce fresh portions of water in distilling. Also that the distillations can be carried safely to dryness with a Wetherill burner, and much less time employed than when a rose or Bunsen burner is employed. Obtained the following results:

I. With 3 grms. of zinc foil, cut into thin threads, and precipitated copper, 2.446 mgrm. KNO_3, distilled 3 times to dryness, 15 c.c. of water being employed each time. Found ammonia, corresponding, in three trials, to 2.38, 2.37 and 2.38 mgrms. KNO_3. In each case, the residue, on redistilling, gave no further traces of ammonia.

II. Precipitated Cu from $CuSO_4$ solution by 1.5 grms. steel turnings, washed carefully, and added 1.5 grms. steel turnings. 2.446 mgrm. KNO_3 distilled 3 times to dryness, 15 c.c. of water each time, gave H_3N, corresponding to 2.454 mgrm. KNO_3. Redistilled 3 times with

* The extensive use which Prof. Thorpe's excellent "Quantitative Chemical Analysis" has deservedly met with, will excuse my calling attention to the erratum on p. 317 of that manual, where the direction is given to double instead of halve the number of c.c. employed in like instance.

15 c.c. gave H_3N, corresponding to 0 015, or a total of 2.469 mgrm. KNO_3.

It will be noted that the results obtained in I. are lower, those in II. higher than the theoretical, and not knowing at the time the true cause of the discrepancy, it was thought advisable to employ with the iron a more electro-positive element than copper. Such a couple exists in pig iron.

III. 3 grms. pig iron, with 2.446 mgrm. KNO_3, were distilled 3 times with 15 c.c. aq. dist. Obtained ammonia corresponding to 5.206 mgrm. KNO_3.

Since the water used in all these and the subsequent experiments was known to contain not the slightest trace of ammonia, the excess of ammonia in III. was probably derived from the nitrogen in combination in the pig iron. Although, in the course of the reduction of potassium nitrate, potassium hydrate had been formed, and pure water, as is well known, is one of the poorest electrolytes known, yet the following experiment was tried with significant result:

IV. 3.65 grm. similar pig iron, distilled 3 times with 15 c.c. aq. dist., gave off 0.01 mgrm. H_3N.

V. Into the flask, after conclusion of IV., 0.3 grm. NaOH (from sodium) was introduced, and the operation continued:

1st	distillation,	3	times	to	dryness	with	15c.c.=0.0325	mgrm.	H_3N.
2d	"	3	"	"	"	"	15c.c.=0.0300	"	"
3d	"	3	"	"	"	"	15c.c.=0.0325	"	"
4th	"	3	"	"	"	"	15c.c.=0.0325	"	"
5th	"	3	"	"	"	"	15c.c.=0.0075	"	"
6th	"	3	"	"	"	"	15c.c.=0.0080	"	"
7th	"	3	"	"	"	"	15c.c.=0.0090	"	"
	Total, ammonia being still evolved,						=0.1520	"	"

Not only is this result of interest in itself, but it is evident that if iron, in any form, is employed in the reduction of nitrates, the precaution must be taken of determining whether the iron alone evolves ammonia, when heated with alkaline solution.

VI. 250 c.c. Passaic water (Nov. 26th, 1877) evaporated to dryness, at the last with a pellet of caustic lime. Residue added to 3 grms. zinc cuttings with spongy copper, and distilled 3 times with 15 c.c. aq. dist. Obtained 0.15 mgrm. H_3N, corresponding to 0.222 parts HNO_3 in 100,000.

VII. 250 c.c. same water, similarly treated, but instead of spongy copper, bright copper obtained on throwing down copper from its sulphate by iron turnings, was employed. Obtained 0.14 mgrm. H_3N.

VIII. 250 c.c. same water, similarly treated, but with 3.9 grm. pig iron as the reducing agent.

1st	distillation,	3	times	to	dryness	with	15c.c.=0.0145	mgrm.	H_3N.
2d	"	3	"	"	"	"	15c c.=0.0175	"	"
3d	"	3	"	"	"	"	15c.c.=0.0150	"	"
4th	"	3	"	"	"	"	15c.c.=0.0250	"	"
5th	"	3	"	"	"	"	15c.c.=0.0100	"	"
6th	"	3	"	"	"	"	15c c.=0.0225	"	"

Total, ammonia being still evolved,=0.235

In other words, 0.085 mgrm. of ammonia above that corresponding to all the nitrates present had been obtained, and the experiment was not concluded.

The above results render it probable, that some of the ammonia obtained in steam condensed from iron boilers, may be due to reduction of the nitrates present naturally in the water used.

New Method for the Estimation of Nitrates in Potable Waters.—The ammonia and albuminoid ammonia were determined in 500 c.c. of Passaic water (Nov. 26th, same sample). The former amounting to 0.002 parts, the latter to 0.02 parts in 100,000. The process was conducted as usual in a litre retort, and when the distillates given off in the second stage of the operation, after the addition of 50 c.c. of potassium permanganate and potash solution, had ceased to contain ammonia, the boiling was interrupted only long enough to introduce 6 grms. of finely divided zinc and spongy copper through the tubulure. The permanganate at once changed color, becoming green, and within two minutes, reddish brown, from conversion into hydrated oxide of manganese.

1st,	100c.c.=0.09	mgrm.	H_3N.	5th,	100c.c.=0.02	mgrm.	H_3N.
2d,	100c.c.=0.25	"	"	6th,	100c.c.=0.01	"	"
3d,	100c c.=0.15	"	"	7th,	100c.c.=0.00	"	"
4th,	100c.c.=0.09	"	"				
	Total.....				0.61	"	"

As 350 c.c. had been distilled off in the determination of the ammonia, it was necessary to add 100 c.c. of boiling aq. dist. before each of the preceding seven distillations, except the first.

The amount of ammonia thus found is about double the true amount, as determined in VI (supra); 50 c.c. of the permanganate solution alone were therefore distilled with 6 grms. zinc-copper, and successive decilitres of aq. dist. Obtained:

1st,	100c.c.=0.30	mgrm.	KNO_3
2d,	100c.c.=0.02	"	"
3d,	100c.c.=0.00	"	"

The total of 0.32 mgrm. subtracted from 0.61 mgrm. gives 0.29 mgrm., coresponding to 0.214 parts HNO_3 in 100,000, which is nearly identical with the result obtained in VI by the usual method.

The advantages of the new method are, that 500 c.c. are sufficient for the three estimations, which are performed consecutively by means of the same simple apparatus. Of course the determination of the nitrates present in 50 c.c. of the permanganate, which should be accurately measured off in a 50 c.c. pipette, is made once for all for the same solution. With assistance of the color-comparator, the three estimations should be concluded within 1¾ hrs.

A greater degree of accuracy however is obtained, though with a corresponding expenditure of time, when the operation is suspended as soon as all the albuminoid ammonia has been distilled over, and the contents of the retort allowed to cool. The zinc-copper couple is then introduced, and allowed to stand an hour, or preferably over night.

The method assumes that the nitrogenous organic compounds, and ammonia as well, are not oxidized by potassium nitrate with the formation of nitrates and nitrites. If such is the case, the validity of the method is destroyed. Suitable experiments have been instituted to determine these points. In the mean time, the close agreement between the amounts of nitrates as estimated by this method and the one usually employed, indicates that in these cases at least, the oxidation, if any such occurred, was too slight to affect the values found.*

Quantitative Estimation of Color in Potable Waters.—The method ordinarily employed is to fill cylinders of a certain diameter and depth, with the same volumes of the waters under examination, and then by descriptive terms to describe the tints as compared with one another and with distilled water. But as a general rule, these tints are not so far different from those which may be obtained by weak solutions of caramel, and these again from those imparted by the Nessler reagent to minute amounts of ammonia in solution, that a properly graduated wedge may not be used in quantitatively estimating depth of tint, in the color-comparator. Thus on Dec. 14th, 1877, the color given by 100 c.c. of Passaic water in one of the comparison tubes, more nearly corresponded to that communicated by the wedge when shoved in to a point equivalent to 0.075 mgrm. ammonia, than to any other point on the scale, and this figure might therefore be taken as expressing the tint of the water at that date.

* Since writing the above, an article has appeared in the Ber. der Deutsch. Chem. Gesell., Vol. X, No. 17, by S. Hoogewerff and W. A. Van Dorp, stating that their experiments show that ammonia does not undergo oxidation by potassium permanganate. Aniline, however, yields nitrates and nitrites in not inconsiderable quantities.

DETERMINATION OF NITRIC ACID BY TRANSFORMATION INTO AMMONIA.

A.—*In Aqueous Solution.*

I. 28 grms. Zn foil in thin cuttings, with spongy copper precipitated from solution of cupric sulphate, distilled to dryness in flask with 0.58 grm. KNO_3 and 50 c.c. water. The distillates were received into normal acid, and titrated with normal soda solution. The distillate corresponded to 11.47 p. c. KNO_3. Residue allowed to stand 48 hrs. with 15 c.c. water and redistilled. Repeated 3 times with 15 c.c. water, an interval of 20 min. being allowed between each distillation. Amount of nitrate corresponding to these 60 c.c. was 2.26 p. c.

II. Conducted similarly, an interval of 42 hrs. elapsing before the first 50 c.c. were distilled over; obtained 54 p. c. Redistilled 3 times with 15 c.c., obtaining an additional 1.11 p. c. Again redistilled 3 times, after addition of 12 grms. zinc cuttings, 2.43 p. c. Total, 57.54 p. c.

III. When 15 grms. copper, obtained by precipitation from cupric sulphate by turnings of soft iron, were employed, with the same amount of zinc cuttings as in previous experiments, eight distillations being made with intervals between them, and 145 c.c. in all of liquid being distilled over, a total of 23.5 p. c. only was obtained. This experiment shows that spongy precipitated copper is essential.

IV. 25 grms. zinc cuttings were left for 10 min. in contact with a warm solution of cupric sulphate, kept strongly colored. A large amount of spongy copper was precipitated, red, not black, as when a dilute cold copper solution was employed. Allowed to stand for 20 hrs. and distilled; yielded 81.6 p. c. Three subsequent distillations with water alone, and a fourth, after addition of 1 grm. soda, afforded no additional result.

B.—*In Alkaline Solution.*

V. 28 grms. zinc cuttings, with copper precipitated as above, were allowed to stand with 50 c.c. water, containing 0.498 grm. KNO_3 (the same amount of nitre as was used in experiments II, III and IV), and 7 grms. potash for 1 hr., and then distilled; obtained 97 p. c. No additional result was obtained on repeating the distillation. In this case, a second flask was used, heated by a second lamp, and its contents carefully redistilled.

C.—*In Alkaline Solution with Pig Iron.*

VI. In apparatus similar to the foregoing, 0.4281 grm. KNO_3 were distilled in contact with 60 grms. very soft gray pig iron and 40 c.c. KOH solution of 15 p. c. The boiling proceeded quietly, the distillation requiring less than $\frac{3}{4}$ hr. Found 100 p. c.

VII. All the analyses in this experiment were made with the *same* 60 *grms. of pig iron.*

	Solution c.c.	Nitre.	Stood cold.	Time in dist.	Found.	Difference.
a	50 aq.	....	....	1 hr.	....	....
b	40 KOH, *a* 15 p. c.	....	½ hr.	1¼ hr.	....	....
c	80 aq.	0.4442 grm.	1 hr.	1 hr.	0.43317 grm.	
d	15 aq. redist.	....	....	....	0.00705	
	Total	....	...	....	0.44022	0.00398
e	65 aq.	0.49789	3 hr.	1¼ hr.	0.49462	0.00327
f	50 aq.	0.49789	....	1¼ hr.	0.4926	0.00529
g	50 aq.	0.49789	....	1¼ hr.	0.4931	0.00478
h	50 aq.	0.49789	....	1¼ hr.	0.49613	0.00176
	15 aq. redist.	....	....	¼ hr.		
i	50 aq.	0.49789	....	1¼ hr.	0.4926	0.00529
	15 aq. redist.	....	....	¼ hr.		
	15 aq. "	....	12 hrs.	¼ hr.		
k	50 aq.	0.49789	....	1¼ hr.	0.49663	0.00126
	15 aq. redist.	....	....	¼ hr.		
	15 aq. "	....	....	¼ hr.		

No alkali was introduced save the 6 grm. KOH in (b), and after being employed in eight analyses, all the ammonia being evolved in each case which could be got over, these 60 grms. of pig iron gave a result corresponding to 99.75 p. c. of the nitre taken. The boiling was very quiet, there being absolutely no frothing; and in expt. VI, where the theoretical result was obtained, only ¾ hr. was required for the distillation, which is less than was required in any of the preceding analyses.

The experiments detailed above were made upon the supposition that the carbon in the pig iron acted as the positive electrode of a galvanic couple, and was essential to the reduction. To test this experimentally, 60 grms. of fine borings of the softest Sweedish wrought iron was heated with 0.5025 grm. of KNO_3 + 50 c.c. KOH solution of 15 p. c. It was allowed to stand 16 hrs. and then distilled, yielding 37.89 p. c. 2.7 grms. of finely divided native graphite were then introduced, and 50 c.c. water. On redistilling, only 4.4 p. c. more was obtained.

This result was confirmed by the repetition of the above experiment in another form. 55 grms. of the softest and finest iron wire which could be procured were cut into small pieces, cleaned with alkali and acid, and distilled with 0.4555 grm. potassium nitrate and 40 c.c. KOH of 15 p. c. But 32 5 p. c. was obtained.

D. *In Aqueous Solution with Examination of Evolved Gases.*

In section A mention is made of using zinc cuttings, or zinc foil cut with shears into as fine threads as possible. But finding that Prof.

Thorpe states in one place (*Jour. Chem. Soc.*, vol. XI, 1873), the zinc employed was 0.084 mm. in thickness, a boring machine was used to turn off the zinc in the thinnest possible borings.

VIII. Forty grammes of such borings and precipitated copper were distilled with 0.5113 grm. KNO_3 and 40 c.c. H_2O, yielding 80.78 p. c. Since the addition of 40 c.c. of KOH solution of 15 p. c. and redistilling gave no additional ammonia, it appeared probable that the ammonia had gone off in some other form.

IX. In the preceding experiment the distillation had been made at once. The same amounts of material being used, but an interval of one hour being left, 95.85 p. c. was obtained. Redistilling with potash gave no further result.

X. To determine whether the whole amount would be obtained in case the reduction was allowed to go on for a sufficient length of time before distilling, the same amounts were used as in VIII and IV, an interval of three hours being allowed. But 93.34 p. c. was obtained.

XI. A flask with 15 grms. zinc and precipitated copper, and with solution containing 1.5 grms. KNO_3, was connected with a worm and condenser in such a manner that the water should be returned to the flask, and the gases pass into an absorption-spectrum tube 1 meter long, and with plates of glass at both ends. The absorption spectrum of nitric peroxide was seen with the spectroscope soon after heat had been applied. With this arrangement the fumes of nitric peroxide were found to be readily visible to the eye, whenever the amounts of nitrates to be reduced were not very small as compared with the amount of zinc employed to effect the reduction. It would appear, therefore, that a certain amount of the nitrogen went off in the form of nitric oxide; and that the amount of error from this cause was smaller as the relative quantity of the reducing agents was greater.

To determine whether nitric oxide was formed by zinc or copper alone, these two metals in a fine state of division were boiled with potassium nitrate solution, and the escaping gases, after condensation of steam passed into an absorption spectrum tube arranged as above. No absorption lines were seen, but when to the zinc, copper was added; or, when to the copper, zinc was added, they presently appeared in the most striking manner.

E. *Does Copper alone effect Reduction of Nitrates to the form of Ammonia?*

It is very noticeable that the precipitate of copper, first thrown down by zinc in a cupric sulphate solution, is red. As the copper is removed from solution, the precipitate alters in character, becoming darker; and finally, when zincic sulphate has replaced the copper salt, quite black. It was shown by Gladstone and Tribe (*Jour. Chem. Soc.*, vol. XI, p. 452),

that the formation of this deposit is due to a secondary action, and that it may contain as much as 7.4 parts Zn to 100 Cu. Without a knowledge of these results of Messrs. Gladstone and Tribe it might have reasonably been assumed that the black deposit was finely divided copper. Alone, without the presence of any zinc, except that which the deposit itself contains, it exercises a powerful reducing action, as the following experiment shows:

XII. Fourteen grms. of the deposit, carefully washed, were heated with 0.24895 grm. of potassium nitrate, and 15 c.c. water. At the beginning of the distillation red fumes were observed, and an amount of ammonia corresponding to 9.71 p. c. of the potassium nitrate obtained.

XIII. Different portions of the deposit were treated with cupric sulphate and dilute sulphuric acid, with most careful washing, the operation being repeated until no traces of zinc were left behind. This pure spongy copper was of a bright red color. All traces of pre-existent ammonia were removed from the apparatus by distilling water through it, until the distillates gave no further indications on Nesslerizing. In three experiments, the copper employed varying in amount from 6 to 12 grammes, and with different degrees of concentration of the potassium nitrate solution, the amount of ammonia formed, if any, was too small to be indicated by the Nessler test. Nor, when the solution was rendered alkaline by potash, was any ammonia liberated.

XIV. A very different result was obtained when pure zinc was digested with a neutral solution of potassium nitrate. 5 grms. zinc in very thin borings, and 2.446 mgrms. potassium nitrate, were distilled three times with 15 c.c. water in successive portions, yielding 0.31 mgrm. ammonia. Three more distillations with 15 c.c. water yielded 0.01 mgrm. The amount of potassium nitrate used corresponded to 0.41 mgrm. ammonia. When the surface of zinc is very large, as compared with the amount of nitrate, the percentage of nitrate reduced is considerable.

It gives me much pleasure to acknowledge the co-operation of my assistant, Dr. Geo. A. Prochazka, in the performance of these somewhat laborious experiments.

III.—Proceedings.

Regular Meeting, February 7th, 1878.

The meeting was called to order at 8.30 P. M., Vice-President Casamajor in the chair. The minutes of the previous meeting were read and approved.

The Committee on Papers and Publications reported, that the next number of the proceedings is in the hands of the printers, and will soon be sent out.

Dr. Goldmark, on the part of the Committee on Rooms, reported that they had been unable to make satisfactory arrangements with the owner of the premises in 14th street, and that they are looking for some other suitable quarters. Dr. Goldsmidt was added to the committee.

The following were elected:

As members—Dr. H. Von Gehren, N. Y.; Dr. Schmitz, Leroy, N. Y.; J. Tschermac, Paris; A. L. Thompson, Berlin.

The following were proposed:

As members—W. H. Baker, Brooklyn; C. E. Colby, N. Y.; Prof. H. S. Munroe, N. Y.

Col. Wm. P. Prentice was proposed as a life associate.

Prof. Leeds read a paper * on some points in water analysis, in which he dwelt on the use of distilled water for that purpose, calling attention to the fact, that it is unnecessary to have the water absolutely free from ammonia, in so far as the quantity of the latter can be easily ascertained by "Nesslerizing." In consequence of the suggestion thrown out by Dr. Chandler at the last meeting, Prof. Leeds has made some experiments to ascertain the action of oxygen on sewage, and found that by the action of pure, filtered air, as well as of ozone, on fresh urine, part of the ammonia present in the same was converted into nitrates, as was conclusively proved by an elaborate series of analyses. Dr. Endemann wished to know, if any bacteria had been found in the urine thus treated; nitrification or oxidation, according to his theory and observations, being due perhaps altogether to the influence of the bacteria in the presence of free oxygen, which they would convey to the non-organized organic part of sewage; also to what extent oxy-

* This paper has been withheld by the author until the investigation shall have been fully completed.

gen would produce oxidation in the absence of bacteria. Prof. Leeds had not yet investigated these points, and stated, that he had considered oxidation in both cases to be due to the presence of ozone, which in one case was obtained by electricity, and conveyed into the fluid; but in the other case had been formed by the evaporation of the water accompanying the experiment. Mr. Casamajor suggested that fine zinc, such as is required for the Zn Cu couple, might be obtained by pulverizing zinc at 400°, or by using zinc amalgam instead of fine turnings. Prof. Leeds had, however, abstained from the use of either from fear of a possible oxidation.

Mr. Dunnington's paper on arragonite containing lead was read; also Mr. Elliott's paper: Tables of Values of Sulphuric Acid, containing a number of data very convenient for practical use, especially for the manufacturer.

Owing to the lateness of the hour, the Committee on Papers was instructed to proceed with the printing of Dr. Iles' paper on the Oxidation of Xylenesulphonic Acids, and postpone its reading until the next meeting.

Mr. Casamajor exhibited a new blowpipe bellows, giving a uniform steady blast lasting from twelve to thirty-five minutes, according to the size of the blowpipe employed.

Adjourned.

M. ALSBERG,
Recording Secretary.

IV.—Analysis of Arragonite, containing Lead.

BY F. P. DUNNINGTON.

This mineral was obtained from the Austin mine, Wythe county, Virginia. It consists of a mass of radiating crystals, from 10 to 20 mm. in length, and from 1 to 3 mm. in thickness; the outer ends of the crystals presenting lateral and terminal faces giving the angles:

$$I \wedge I = 116°15' \text{ (average.)}$$
$$1-i \wedge 1-i = 109°$$

Hardness=3.5; sp. gravity=3.078; white, transparent.

Giving the following composition:

CaO	51.819	$CaCO_3$=92.516
PbO	6.087	$PbCO_3$= 7.289
CO_2	41.800	
Fe_2O_3	.033	
SiO_2	.012	
H_2O	.070	
	99.821	

If we replace the lead present by an equivalent amount of calcium, considering it to occupy the same space, we would have the sp. gravity=2.937, according with that of arragonite.

This mineral may be of some interest, as the only analysis of tarnovicite given by Prof. Dana, is one of a specimen containing but 3.859 of lead carbonate.

V.—On the Oxidation of Xylenesulphonic Acids.

BY MALVERN W. ILES, PH. D.

The results obtained in the oxidation of the sulpho- acids of toluene and mesitylene made it appear probable, that if the pure sulpho- derivatives of the different varieties of xylene, could be obtained in sufficient quantities, and then by subjecting them to oxidation, conclusions of value could be drawn in reference to their constitution. The first difficulty to be overcome, was the preparation of derivatives, of which it could be proven, that they were obtained from but one of the varieties of xylene.

The complicated and tedious methods, by which the ortho- meta- and para-xylenes may be prepared, furnish such comparatively small quantities, that there was little hope, that the object could be accomplished by adopting them.

On the other hand, no method is known, by which it is possible to separate meta- from the para-xylene variety, as they occur in coal tar, notwithstanding the fact, that many efforts have been made to find such methods. The prospect of effecting a separation of the two xylenes by means of the sulphamides seemed sufficiently promising to warrant the experiment. This I accordingly did upon the suggestion of Prof. Remsen.

Jacobsen (Annalen der Chemie, 184, 179), in his investigation, describing the separation of mesitylene from pseudocumene, refers to two

sulphamides, which he obtained, apparently in a pure condition, and proved to be derived from iso- or meta-xylene.

Of course it remained to be seen whether the necessarily complex product, formed by the action of sulphuric acid upon xylene and the subsequent conversion of the sulpho- acids into the sulphamides could, by partial crystallization, be separated into its constituents.

The xylenesulphonic acids were prepared by taking a sample of commercial xylene from E. Schering, and after repeated fractional distillations for several weeks, the product boiling between the points 139° and 143° C. was very gradually treated with an equal volume of concentrated sulphuric acid sp. gr. 1.811.

Care should be exerted to frequently agitate, and to keep the temperature low, as otherwise decomposition products will ensue, which color the mass more or less dark and give rise to a considerable evolution of sulphur dioxide.

After all the oil has been acted upon, the mass should be diluted with water and neutralized with chalk. Upon filtering, a solution of the calcium salt of the sulpho- acid is obtained. The sodium salt was then made by the addition of sodium carbonate until the precipitate of calcium carbonate ceased to appear.

The reactions may be expressed as follows:

1.—$C_8H_{10}+H_2SO_4=C_8H_9.SO_2OH+H_2O$

2.—$2(C_8H_9.SO_2OH)+CaCO_3=(C_8H_9.SO_2.O)_2Ca+H_2O+CO_2$

3.—$(C_8H_9.SO_2.O)_2Ca+Na_2CO_3=2(C_8H_9.SO_2ONa)+CaCO_3$

The sodium salt was then evaporated to dryness upon a water bath, and the salt thus obtained treated by degrees with an equal weight of phosphorous pentachloride; the reaction is quite violent, and it becomes necessary, in order to insure good results, to lower the temperature, preferably by the use of a large evaporating dish resting in another dish of similar size, containing a freezing mixture of ice and salt.

The resulting oil, of a purplish red color, was decomposed by means of concentrated aqueous ammonia. A very violent reaction ensued and large quantities of ammonium chloride were formed; the temperature should also here be kept as low as possible.

The reactions may be expressed as follows:

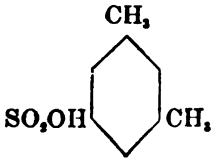
4.—$C_8H_9.SO_2.ONa+PCl_5=C_8H_9SO_2Cl+NaCl+POCl_3$

5.—$C_8H_9SO_2Cl+NH_3=C_8H_9.SO_2NH_2+HCl.$

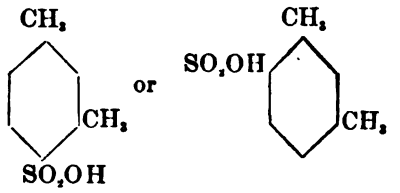
As will be readily seen, if, in ordinary xylol, there are present both the para- and meta- varieties, four different isomeric sulpho- acids may be

obtained by the introduction of one sulpho-group into the hydrocarbon. From meta-xylene three monosulpho-acids may be derived, as follows:

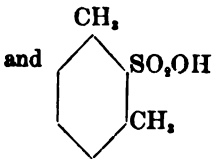
I.



II.



III.



and from para-xylene only one variety is possible. Taking into consideration the fact noticed in connection with toluenesulphonic acids, that the sulpho-group appears to have a tendency to take a position as far removed from the methyl as possible, there would be expected from meta-xylene, mainly the formation of the compound represented by the formula I, above given, together with those represented by formulas II and III, in smaller quantities.

Experiment showed, that when the sulpho-acids obtained by the action of sulphuric acid on the xylene from coal tar, are converted into sulphamides, three well characterized compounds are obtained, and that these may be separated from one another comparatively easy.

After an excess of ammonia has been added to the compound $C_6H_3.SO_2Cl$, with the precautions previously indicated, the complex mixture should be heated upon a water bath for several hours, thus expelling much phosphorous oxychloride and free ammonia. Then allow to stand at least 12 hours, when there will be found a brownish red supernatant liquid, containing the salts. This should be decanted off, and may be thrown away, as numerous attempts to recover any amide proved unsuccessful. The residual mass, consisting of two distinct portions, is then thoroughly washed with cold water, to remove more completely the inorganic salts.

The washed amides will be found to be divided approximately into two portions; first there will be the greater portion in the form of white flat plates (amide No. 1) resting upon a light yellow solid body

(amide No. 2), which may be removed mechanically and treated separately, thereby greatly facilitating the process of purification.

The solid mass should be treated with just sufficient water to cover it, when on heating gently it will separate for the most part in the form of an oil, while amide No. 1 will go into solution.

Of the three varieties of sulphamides actually obtained and separated from one another, two are identical with those incidentally referred to by Jacobsen. One of these fuses at 137° C., and the other at 100°. The former crystallizes in long flattened plates, and the latter in the form of very long needles.

The third variety does not crystallize, but always separates in the form of verrucose masses, which by repeated separations may be obtained pure.

On heating up the crude mass of washed amides with water, an oil always separates at the bottom of the vessel, while the solid matter dissolves in the water. On pouring off the aqueous solution, and allowing to cool, that which crystallizes out consists almost entirely of the amide which fuses at 137° (amide No. 1).

The oil may be dissolved in boiling water, and the solution yields mainly the amide which fuses at 100° C. (amide No. 2).

By crystallization both of these products may be obtained in a pure condition. The verrucose masses above referred to, appear in the evaporated mother liquors from the first varieties, and by proper manipulation, can be separated from either of the other two. They fuse at 143°, 144°. In the performance of this investigation, I have been engaged in separating the amides derived from more than two pounds of the crude sodium xylenesulphonates.

As a general result of the investigations, it may be stated, that the amide of fusing point 137° is formed in by far the largest quantity; that the amide of fusing point 100° is obtained in about one-fourth the quantity of the first, and finally the verrucose masses are formed in considerably smaller quantity, than either of the other two varieties. Jacobsen converted both the amides under consideration into the xylene, from which they were obtained, and proved that they were both derivatives of meta-xylene. The conversion was effected by heating the sulphamides with concentrated hydrochloric acid under pressure, and the nature of the resulting hydrocarbon was determined by transformation into the trinitro compound. In both cases the same trinitro compound was produced, and this had the fusing point and other properties characteristic of trinitro meta-xylene.

It is thought, that the amide of fusing point 137° has the constitution represented by formula I. (see *ante*), as in this, the sulpho-group is as far removed from the two methyl groups as it can be. As will be

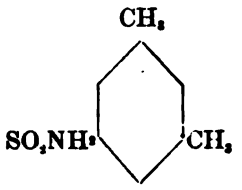
seen, the sulpho group occupies the meta- position with reference to both methyl groups.

No investigation had as yet been made to show, what the influence of oxidizing agents would be upon compounds, having the sulpho- group in the meta- position; but one thing appeared to be highly probable, that if by oxidation the methyl groups were converted into carboxyl, a bibasic acid would result, if the oxidation was carried to its limit, inas much as the sulpho- group is situated symmetrically with reference to the two methyl groups, that these must be affected alike by this group. The other possibility was, that the whole compound might be broken up, as in the case of the ortho- compounds.

When this amide is treated with the usual oxidizing mixture of potassium dichromate, sulphuric acid and water, and heat is gently applied until the liquid manifests a slight agitation upon the surface, there ensues quite a violent chemical action, accompanied by the disengagement of considerable carbon dioxide and an odor of fatty acids, which is quite perceptible.

By this mode of oxidation the amide has not, up to the present time, yielded the slightest indication of the formation of an acid. The amide, it would seem, resists the action entirely, or, in case it is acted upon, in such a manner as to be entirely decomposed.

Of course, from this experiment there can be drawn no conclusion in regard to the constitution of the sulphamide, but it is believed, that the results of the oxidation of the next amide (fusing point 100°) justify the acceptance of the formula above given as probable for the first amide, viz.:



On subjecting the amide of fusing point 100° to the action of the chromic acid oxidizing mixture, a very marked difference is noticed between this case and the one just described. In this, the action does not begin until the boiling temperature is reached, and it then continues very slowly, and requires several hours for completion.

In my first attempts to completely oxidize this amide, the oxidation was continued for three days, before all the melted amide had disappeared from the surface of the liquid, and upon then allowing to cool and filtering, a white crystalline body was obtained in the form of thickened needles, which by repeated crystallizations may be obtained in a pure condition.

Subsequent experiments have conclusively proven, that the oxidation was continued entirely too long to obtain the best yield of acid, and that there is a deceptive agent towards the end of the reaction, owing to the presence of an oil which does not solidify upon cooling, which can be, therefore, easily distinguished from the oil which amide No. 2 forms. At what stage this body is formed in the preparation of the sulphamides, it is difficult to say.

Owing to the small amount obtained, this body has not yet received careful examination, further than the fact, that it is readily acted upon by concentrated nitric acid, yielding a crystalline body of a high melting point (over 300° C.)

The crystalline body formed in the oxidation of amide No. 2, or meta-xylene, has the fusing point 247° to 248° when pure, and has the properties of an acid. It dissolves readily in sodium carbonate, and is precipitated from the solution by the addition of a strong mineral acid, this new acid coming down as a compact powder. It is comparatively easily soluble in hot water, but with difficulty in cold water. Upon crystallization of the precipitated acid, peculiar thick pointed prismatic crystals are obtained, which, under certain circumstances, attain considerable size; furthermore, this acid has a very remarkable tendency to alter the form of crystallization according to the surrounding circumstances, no less than seven distinct modifications having been noted. The melting point in all of these cases remains the same.

By boiling the acid with barium carbonate, the acid was converted into the barium salt. This was found to be easily soluble in water, but from the concentrated solution it finally separated in a rather compact mass consisting of very delicate silken needles. The air-dried crystals were analyzed with the following results:

I. 0.3865 grams dried salt gave 0.158 $BaSO_4$=0.09204 Ba.

II. 0.157 grams dried salt gave 0.06475 $BaSO_4$=0.03807 Ba.

III. 0.1815 grams salt lost 0.025 grams H_2O, at 200° C.

IV. 0.1360 grams salt lost 0.01888 grams H_2O, at 180° C.

These results correspond to 24.04 p. c. and 24.25 p. c. Ba, respectively, and 13.77 p. c. and 13.82 p. c. H_2O. The formula

$$(C_6H_3.CH_3.SO_2NH_2.COO)_2\,Ba+5H_2O$$

requires 24.25 p. c. Ba and 13.74 p. c. H_2O.

The following salts of sulphaminemetatoluic acid were examined:

The *sodium salt* is very easily soluble in water, and crystallizes in delicate needles.

The *copper salt*, prepared by precipitating the barium from a solution of the barium salt by means of copper sulphate, can be obtained by careful evaporation in delicate radiating needles of a blue color. If

evaporated by boiling, the salt is partly decomposed, and a light blue, difficultly soluble powder is thrown down.

The *cobalt salt* crystallizes in small, round, very compact, radiating needles. It is easily soluble in water.

The *calcium salt*,

$$(C_6H_3.CH_3.SO_2NH_2.COO)_2Ca + 1\tfrac{1}{2}\ H_2O$$

was prepared by neutralizing a solution of the acid in water with finely powdered Iceland spar. It is easily soluble in water, and crystallizes in small, concentrically arranged needles. Its analyses yielded results as follows:

I. 0.362 grams salt lost 0.01950 grams H_2O at 200°, and gave 0.101 grams $CaSO_4$.

II. 0.3145 grams lost 0.0170 grams H_2O at 195°, and gave 0.0875 grams $CaSO_4$.

These figures correspond to 8.21 p. c. and 8.18 p. c. Ca, and to 5.38 p. c. and 5.40 p. c. H_2O respectively. The formula

$$(C_6H_3.CH_3.SO_2NH_2.COO)_2Ca + 1\tfrac{1}{2}\ H_2O$$

requires 8.08 p. c. Ca, and 5.45 p. c. H_2O.

The *silver salt* was prepared by adding silver nitrate to a solution of the ammonium salt. It is precipitated in flocculent masses, which may, however, be obtained in the form of needles by recrystallization from water.

The salt was analyzed:

I. 0.083 grams salt gave 0.02775 grams Ag.

II. 0.10125 grams salt gave 0.03375 grams Ag.

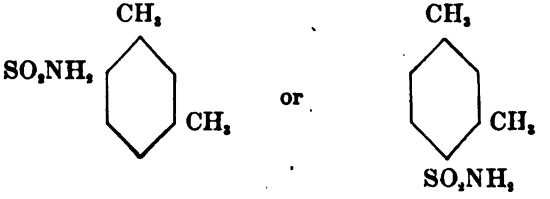
These figures correspond to 33.43 p. c. and 33.33 p. c. Ag, respectively. The formula $C_6H_3.CH_3.SO_2NH_2.COO\,Ag$ requires 33.54 p. c. Ag.

It will be seen from the above analyses, that the acid is monobasic, or, in other words, that only one of the methyl groups has been converted into carboxyl. Now, as the original sulphamide was treated for three days with an excess of the oxidizing mixture, and the second methyl group remained unaffected, it is plain that the sulphamine group must be situated in the molecule in such a way as to influence the two methyl groups differently.

This result could hardly be reached if the SO_2NH_2 group were situated symmetrically with reference to the two methyl groups; and it seems altogether more probable, that the difference noticed in the methyl groups is due to the fact, that the sulphamine group is situated differently with reference to them.

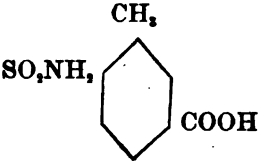
This conclusion is reached, as will be seen, independently of any hypothesis. There can, however, by means of Kekulé's hypothesis, be given a probable expression to the fact.

Of the three varieties of metaxylene-sulphamide possible according to the hypothesis (see *ante*, p. 17), only one has the sulphamine group situated differently with reference to the two methyl groups, viz.:



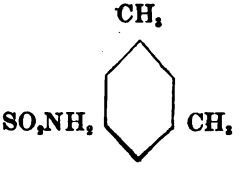
the two formulas being, as is evident, identical.

The facts above described furnish, as is believed, the proof that this formula is the correct one for the amide which fuses at 100°. It will be seen that in this substance the SO_2NH_2 group has the para- position with reference to one of the methyl groups, and the ortho- position with reference to the other. There can hardly be any doubt, but that the para-methyl is the one changed by the oxidation, so that a very probable formula for sulphaminemetatoluic acid may be given as follows:



It seems probable that if the group COOH can be introduced in the place of the SO_2NH_2 group, xylidinic acid would result.

As regards the amide which fuses at 137°, the sulphamine group in it may be situated in the ortho- position, or in the meta- position with reference to both of the methyl groups. As has been stated above, the fact that, the sulpho- group has a tendency to take a position as far removed from the methyl as possible, leads to the belief, that that formula for the amide under consideration is correct, which represents the sulphamide group in the meta- position with reference to both the methyl groups, viz.:



In previous publications a statement was made (see notes from the Chem. Lab. Johns Hopkins University, Nos. 1–3; also Berichte der

deutschen chemischen Gesellschaft, X, 1042), that probably the verrucose masses (amide No. 3) would be shown to be derived from para-xylene, as the derivatives of this hydrocarbon in general differ from those of meta-xylene in not crystallizing. This supposition I have since proven to be correct; the mode of procedure will be given in a later portion of this article.

I have exercised the greatest care in examining the products with reference to the possible presence of more than three amides, but with entirely negative results.

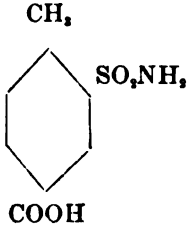
In a recent notice concerning this investigation (Berichte der deutschen chemischen Gesellschaft, X, 1200), the formation of an acid differing from sulphaminemetatoluic acid was mentioned by Prof. Remsen. This acid I obtained by oxidizing a mixture of the amide of fusing point 100°, and the third amide.

Since the publication of the notice referred to, I have obtained a considerable quantity of this second acid by oxidizing the third amide.

7 5 grams of the amide were treated with the oxidizing mixture, consisting of 20 grams potassium bichromate, and the usual proportions of sulphuric acid and water. The flask containing the mixture was heated gently for several hours. After cooling, a crystalline body separated, which was filtered off and washed. In order to free this product from any unoxidized amide which might be present, it was crystallized from water once or twice, and then dissolved by means of dilute sodium carbonate. The solution, thus prepared, could be evaporated to a small volume without any separation of the acid, while any amide present would crystallize out. On then filtering. and decomposing the sodium salt with hydrochloric acid, the pure acid is thrown down. This method of purification was found very convenient and valuable, in connection with both the acid now under consideration and the sulphaminemetatoluic acid previously described. After crystallization from water, the acid separates in the form of beautiful, long, silken needles. It fuses at 267°, when pure. It is difficultly soluble in cold water, though comparatively easily soluble in hot water. It is readily soluble in alcohol, both hot and cold; and nearly insoluble in ether, even when the liquid is heated. Sometimes, from a solution containing the pure acid, uncrystallized nodules separate together with the characteristic silken needles. These were found to be the acid itself, which is thus deposited from concentrated aqueous solutions. On diluting these same solutions, redissolving the nodules, and again allowing to crystallize, the whole of the acid frequently separated in the needles described. From alcoholic solutions the acid crystallizes in fine, concentrically arranged needles, which are not as long as those obtained from water. In order to determine whether this new acid is derived from para-xylene or meta-xylene,

about 5 grams were treated with concentrated hydrochloric acid in a sealed tube. The tube was heated finally to 220°, at which temperature it was kept for four hours. Upon cooling, crystals were deposited from the liquid. These were filtered off and recrystallized, and, after drying, were sublimed. They then fuse at 174°. Although paratoluic acid, when perfectly pure, melts at 178°, still the properties of this substance were such as to leave little doubt that it was really paratoluic acid. This was rendered still more certain by another experiment. A small quantity of the supposed paratoluic acid was treated with potassium bichromate and sulphuric acid. It was thus converted into an acid which is insoluble in water, and did not fuse at 310°. This, in all probability, is terephthalic acid. The analysis of a number of its salts, the results of which are given below, show conclusively, that its composition is that of a sulphaminetoluic acid; and the formation of paratoluic acid from it, by the extraction of the sulphamine group, shows, that it is a derivative of paratoluic acid. It only remains to be decided, whether the sulphamine group is situated in the ortho- position with reference to the CH_3, or with reference to the COOH group.

The fact, that only one of the methyl groups is oxidized, indicates, that one is protected by some influence, and, as we have seen, that a substituting group in the ortho- position will exert such a protective influence, it may be considered as established, that the sulphamine group, in the acid we are considering, is in the ortho- position with reference to the methyl group. Hence the constitution of the acid is expressed by this formula:



It is sulphamineparatoluic acid, $C_6H_3.CH_3.SO_2NH_2.COOH$. Descriptions of some of its salts follow:

The *barium salt* $(C_6H_3.CH_3.SO_2NH_2.COO)_2Ba+2H_2O$, was prepared by boiling the acid in water with pure barium carbonate. It crystallizes in concentrically arranged, compact needles, which are easily soluble. The crystals attach themselves firmly to the beaker in hard lumps. The salt was analyzed with the following results:

I. 0.2302 grams salt lost 0.0132 grams H_2O at 200°, and gave 0.089 grams $BaSO_4$.

II. 0.359 grams lost 0.0218 grams H_2O at 200°, and gave 0.1385 grams $BaSO_4$.

These results correspond to 22.73 p. c. and 22.06 p. c. Ba respectively, and to 5.73 p. c. and 6.07 p. c. H_2O. The formula $(C_6H_3.CH_3.SO_2NH_2.COO)_2Ba+2H_2O$ requires 22.79 p. c. Ba and 5.99 p. c. H_2O.

The *calcium salt*,

$$(C_6H_3.CH_3.SO_2NH_2.COO)_2Ca+4H_2O$$

was prepared by treating the acid with finely powdered Iceland spar. It crystallizes from water in very compact, radiating needles of a beautiful pearly luster. It is easily soluble in water. The analyses resulted as follows:

I. 0.1950 grams salt lost 0.026 grams H_2O at 195°, and gave 0.050 grams $CaSO_4$.

II. 0.22325 grams salt lost 0.02975 grams H_2O at 195°, and gave 0.05725 grams $CaSO_4$. These figures correspond to 7.54 p. c. and 7 54 p. c. Ca; and to 13.33 p. c. and 13.32 p. c. H_2O respectively. The formula $(C_6H_3.CH_3.SO_2NH_2.COO)_2Ca+4H_2O$ requires 7.41 p. c. Ca and 13.33 p. c. H_2O.

The *manganese salt*,

$$(C_6H_3.CH_3.SO_2NH_2.COO)_2Mn+5H_2O$$

was prepared by neutralizing an aqueous solution of the acid with pure manganese carbonate. It crystallizes in small needles, which are easily soluble in water. The analysis yielded results as follows:

I. 0.1785 grams salt lost 0.02325 grams H_2O at 180°, and gave 0.02425 grams Mn_3O_4.

II. 0.1620 grams salt lost 0.02525 grams H_2O at 180°, and gave 0.02175 grams Mn_3O_4. These figures correspond to 9.79 p. c. and 9.67 p. c. Mn; and to 15.83 p. c. and 15.59 p. c. H_2O respectively. The formula $(C_6H_3.CH_3.SO_2NH_2.COO)_2Mn+5H_2O$ requires 9.60 p. c. Mn, and 15.70 p. c. H_2O.

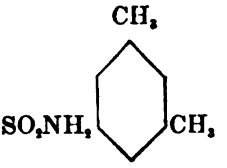
The sulphamineparatoluic acid will be studied more fully. There are particularly two transformations, which it seems probable to effect. These are the formation of an oxytoluic acid and a bibasic acid by the conversion of the sulphamine groups into hydroxyl and carboxyl respectively. The bibasic acid would be isomeric with xylidinic acid.

Since the publication of the previous communication, some new facts have been established which require notice. The acid fuses at 247° to 248°, and not at 235°, as has been incorrectly stated. It dissolves easily in alcohol, and crystallizes from the solution in peculiar curved prisms. It is insoluble in ether, like the isomeric acid.

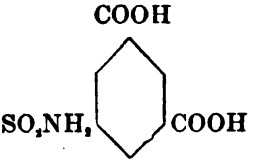
Sulphaminemetatoluic acid was treated with concentrated hydrochloric acid, for the purpose of extracting the SO_2NH_2 group. It was

heated first to 220°, at which temperature sulphamineparatoluic acid is transformed into paratoluic acid, but was decomposed entirely, free carbon separating. It was heated up to 150°, but at this temperature also complete decomposition ensued. Special experiments were then undertaken to determine the temperature, at which the decomposition takes place. If the substance is not heated above 130°, the acid separates upon cooling unchanged. Above 140° decomposition takes place. Experiments with dilute hydrochloric acid gave similar results; no metatoluic acid could be obtained. This difference in the isomeric acids is instructive, and suggests further investigation of similar cases.

I will add yet, that recently I have discovered three further new acids, making, in all, five new acids. One of these I have analyzed and find to be a bibasic acid, and derived from sulphamine-metaxylene:



This substance (amide No. 1), by oxidation with potassium permanganate, yields a bibasic acid, which may be represented by the formula:



Further descriptions of these very interesting acids will be given in a later communication.

VI.—Table of Values of Sulphuric Acid.

BY A. H. ELLIOTT.

The accompanying table is the result of a careful selection of figures from standard authorities, and calculations from those figures have been worked out into forms that are constantly needed in a chemical manufactory. The columns with headings marked "Degrees Beaumé," "Specific Gravity," and "Per Cent. of H_2SO_4," are after the figures of the table of the Manufacturing Chemists' Association. A comparison of these figures with those of Binson and Kolbe, shows them to be the

latest and most reliable result. The sixty-sixth degree of Beaumé* is placed at 1.835 specific gravity, not because this is the highest attainable strength, but because this is the specific gravity of the acid sold and branded "66° Oil of Vitriol" in commerce. Acid of a higher specific gravity is difficult to prepare, and is unnecessary for the ordinary uses to which oil of vitriol is put. In other words, "Oil of Vitriol" contains ninety-three and a half per cent. of monohydrated acid (H_2SO_4), and this is now a settled question amongst chemical manufacturers.

Starting with the above data, I have calculated the weight of a cubic foot of acid at the various densities, and worked out the figures in the other columns. I have added the nearest degree of Twaddel's hydrometer corresponding to the various specific gravities. This latter hydrometer is a much more reliable instrument to place in the hands of a workman than that of Beaumé, because the degrees are more easily read, and a difference of a quarter or even a half degree does not make as much difference as the same error on Beaumé's scale. But since it is a trade custom to use the latter hydrometer, a definite understanding of its value is very important.

The boiling points given are after the figures of Dalton. The specific gravity of sulphuric acid in the accompanying table is that obtained at a temperature of 60° Fahrenheit (15.5 Celsius). The number of degrees Fahrenheit, causing a rise or fall of one degree Beaumé, is given in the last column. Thus a rise or fall of forty degrees Fahrenheit in the temperature of acid ranging from sixty to sixty-six degrees Beaumé (at 60° Fahrenheit), causes a fall or rise of one degree Beaumé. In other words, acid of 63° Beaumé at 60° Fahrenheit will stand 62° at 100° Fahrenheit; or it will stand at 64° at a temperature of 20° Fahrenheit, and so on for each set of figures given in the last column.

The term O.V. in the table is the contraction of "Oil of Vitriol," or acid of 93.5 per cent. of H_2SO_4. The term 60° acid means acid containing 77.6 per cent. H_2SO_4.

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* The total number of degrees of this areometer would be 145. (N = 145.04). [The Committee on P. & P.]

Degrees Beaumé.	Specific Gravity.	Per cent. H_2SO_4.	Per cent. O.V.	Weight of cubic foot.	Per cent. 60° Acid.	Pounds of O.V. in cubic foot.	Pounds of 60° Acid in cubic foot.	Nearest degree of Twaddel.	Boiling Point, Degrees Celsius.	Boiling Point, Degr. Fahrenheit.	Correction for Temperature.
1	1.005	0.93	1	62.8	0.78	0.62	0.45	1	....	....	....
2	1.011	1.87	2	63.2	1.46	1.26	0.92	2	....	....	....
3	1.023	3.74	4	63.9	2.92	2.55	1.86	4.5	....	....	....
4	1.029	4.67	5	64.3	3.64	3.21	2.33	5.7	....	....	....
5	1.036	5.61	6	64.7	4.37	3.88	2.83	7	....	....	....
6	1.043	6.54	7	65.2	5.10	4.56	3.32	8.5	....	....	....
7	1.050	7.48	8	65.6	5.83	5.25	3.82	10	....	....	....
8	1.057	8.41	9	66.0	6.56	5.94	4.33	11.5	....	....	....
9	1.064	9.35	10	66.5	7.29	6.65	4.85	13	....	....	....
10	1.071	10.28	11	66.9	18.16	7.36	8.80	14	....	....	43°
11	1.086	12.15	13	67.8	15.45	8.81	10.47	17	....	....	....
12	1.093	13.09	14	68.3	16.75	9.56	11.44	18.5	....	....	....
13	1.100	14.02	15	68.7	17.94	10.30	12.32	20	103	217	....
14	1.107	14.96	16	69.2	19.15	11.07	13.25	21.5	....	....	....
15	1.114	15.89	17	69.6	20.34	11.83	14.15	23	....	....	....
16	1.122	16.83	18	70.1	21.54	12.62	15.10	24.5	....	....	....
17	1.136	18.70	20	71.0	23.93	14.20	16.99	27	....	....	....
18	1.143	19.63	21	71.4	25.12	14.99	17.93	28.5	....	....	...
19	1.150	20.57	22	71.8	26.33	15.79	18.90	30	....	....	....
20	1.158	21.50	23	72.3	27.52	16.63	19.89	31.5	....	....	30°
21	1.172	23.37	25	73.2	29.91	18.30	21.89	34.5	....	....	....
22	1.179	24.31	26	73.7	31.11	19.16	22.93	35.7	....	....	....
23	1.186	25.24	27	74.1	32.31	20.00	23.94	37	....	....	....
24	1.201	27.11	29	75.0	34.70	21.75	26.02	40	107	224	....
25	1.208	28.05	30	75.5	35.90	22.65	27.10	41.5	....	....	....
26	1.216	29.98	31	76.0	37.15	23.56	28.23	43	....	....	....
27	1.231	30.85	33	76.9	39.55	25.37	30.41	46	....	....	....
28	1.238	31.79	34	77.4	40.75	26.31	31.54	47.5	....	....	....
29	1.254	33.66	36	78.4	43.15	28.22	33.83	51	....	....	...
30	1.262	34.59	37	78.9	44.34	29.19	34.98	52.5	....	....	30°
31	1.269	35.53	38	79.3	45.55	30.13	36.12	54	....	....	....
32	1.285	37.40	40	80.3	47.95	32.12	38.50	57	....	....	....
33	1.293	38.33	41	80.8	49.14	33.13	39.70	58.5	115	239	....
34	1.309	40.20	43	81.8	51.54	35.17	42.16	62	....	....	....
35	1.317	41.14	44	82.3	52.74	36.21	43.40	63.5	....	....	....
36	1.334	43.01	46	83.4	55.14	38.36	45.98	67	....	....	....
37	1.342	43.94	47	83.9	56.33	39.43	47.26	68.5	....	....	....
38	1.359	45.81	49	84.9	58.73	40.75	49.86	72	....	....	...
39	1.368	46.75	50	85.5	59.93	42.75	51.24	73.5	....	....	....
40	1.386	48.62	52	86.6	62.33	45.03	53.98	77	....	....	31°
41	1.395	49.55	53	87.2	63.52	46.21	55.39	79	....	....	....
42	1.413	51.42	55	88.3	65.92	48.56	58.21	82.5	128	262	....
43	1.422	52.36	56	88.9	67.12	49.78	59.67	84.5	....	....	....

Degrees Beaumé.	Specific Gravity.	Per cent. H_2SO_4.	Per cent. O.V.	Weight of cubic foot.	Per cent. 60° Acid.	Pounds of O.V. in cubic foot.	Pounds of 60° Acid in cubic foot.	Nearest degree of Twaddel.	Boiling Point, Degrees Celsius.	Boiling Point, Degr. Fahrenheit.	Correction for Temperature.
44	1.441	54.23	58	90.0	69.52	52.20	62.57	88	....	....	....
45	1.451	55.16	59	90.7	70.71	53.51	64.13	90	....	....	...
46	1.470	57.03	61	91.9	73.11	56.06	67.19	94	...	....	....
47	1.480	57.97	62	92.5	74.32	57.35	68.74	96	....	....	....
48	1.500	59.84	64	93.7	76.71	59.97	71.88	100	....	....	...
49	1.510	60.77	65	94.4	77.91	61.36	73.55	102	....	....	....
50	1.531	62.64	67	95.7	80.31	64.12	76.85	106	144	292	38°
51	1.541	63.58	68	96.3	81.51	65.48	78.49	108	....	....	....
52	1.562	65.45	70	97.6	83.91	68.32	81.89	112.5	....	....	....
53	1.573	66.38	71	98.3	85.10	69 69	83.65	114.5	....	....	....
54	1.594	68.25	73	99.6	87.50	72.71	87.15	119	....	....	....
55	1.616	70.12	75	101.0	89.89	76.05	90.79	123	....	....	....
56	1.627	71.06	76	101.7	91.10	77.29	92.65	125.5	....	....	...
57	1.650	72.93	78	103.1	93.50	80.42	96.40	130	177	350	....
58	1.661	73.86	79	103.8	94.69	82.00	98.29	132	180	354	....
59	1.683	75.73	81	105.2	97.08	85.21	102.13	136.5	186	367	....
60	1.705	77.60	83	106.5	100.00	88.39	106.50	141	192	378	40°
61	1.727	79.47	85	107.9	101.88	91.71	109.93	145.5	200	392	....
62	1.747	81.34	87	109.2	104.28	95.00	113.87	149.5	205	401	...
63	1.767	83.21	89	110.4	106.68	98.25	117.77	153.5	217	422	....
64	1.793	86.02	92	112.0	110.28	103.04	123.51	158.5	230	446	....
65	1.814	88.82	95	113.4	113.87	107.73	129.13	163	249	480	....
66	1.835	93.50	100	114.7	119.87	114.70	137.49	167	272	523	40°

VII.—Contributions to Blow-pipe Chemistry.

First Paper.—New Blow-pipe Bellows.

BY P. CASAMAJOR.

This apparatus works by water pressure. It is formed of two drums, A and B (see fig. 1), connected by a pipe C, open at both ends, which I will call the *water-pipe*. Another pipe D, which I will call the *outlet air-pipe*, is connected with both drums, and serves to carry off the compressed air from the lower drum to the nozzle of the blow-pipe. In addition to these, the drum A is provided with a tube E, and the drum B with a tube F, which I will call the *inlet air-pipes*. The function of these is to admit air into the upper drum.

The upper and lower drums are firmly fixed on two upright pieces of wood M N and O P, which are provided with journals G and H, which turn in bearings attached to a frame. One of the journals H is hollow, and through it passes a tube, soldered to pipe D, which serves to carry the air of the lower drum to the blow-pipe.

If we suppose, that the upper portion of the pipe D and that the pipe F are closed, while the lower part of the pipe D and the pipe E are open, and if, moreover, we suppose that the upper drum A is full of water, while the lower drum B is full of air, we may see that the water in A will run down the water-pipe C, and fall in the lower drum. This produces pressure in this drum, which drives the air in it to the blow-pipe, through the lower part of the pipe D. As the water descends to the lower drum, air is admitted to the upper one through the inlet air-pipe E, so that finally the lower drum becomes full of water and the upper one full of air. We may then turn the drums on their journals G H, so as to place the drum B above the drum A. If now we close the inlet air-pipe of the lower drum and the upper portion of the pipe D, while we open the inlet air-pipe F of drum B and the lower part of the outlet air-pipe D, the water of B, as it descends into A, will drive out the air of this drum to the blow-pipe, through the tube D. When this action is over, the apparatus may again be reversed with the same result as before, and so on indefinitely.

It may be noticed, in figure 1, that the tubes C and D are curved instead of being straight. The object of these curves is to prevent the expansions and contractions of these tubes from injuring the drums, as these are held apart by the pieces of wood M N and O P, whose longitudinal expansions and contractions are insignificant when compared to those of the tubes, which are of metal. It may also be noticed that the water-pipe C terminates at each end by a curved portion, the object of which is to keep the lower part of this pipe full of water, when the water runs down to prevent the air of the lower drum from ascending through this pipe into the upper drum.

I have mentioned that it is essential for the proper working of this apparatus, that the upper inlet air-pipe and the lower portion of the outlet air pipe D should be left open, while the lower inlet air-pipe and the upper part of the outlet air-pipe D should be tightly closed. It would be possible to accomplish these alternate openings and closings of air-pipes by providing each inlet air-pipe with a cock, and the outlet air-pipe D with two cocks, each placed between one of the drums and the middle of the pipe D. By alternately opening and closing these cocks with the hand, the desired object would be accomplished, but it has been found more convenient to use valves, which open and close automatically. As these valves must close very tightly, and with considerable

pressure, I use the arrangement shown in figure 2, which works with entire satisfaction.

In figure 1, it may be noticed that the pipes C, D, E, F are enlarged at the portions at which they are inserted in the drums. These enlargements correspond to screw couplings, which, in the case of the water-pipe C and the outlet air pipe D, consist of two tubes, R and S, of which R is provided with a screw. A nut T works in the screw of the tube R, and this nut is provided with a shoulder, which presses down on the rim of the tube S, so that by turning this nut, the tubes R and S are brought tightly together. Between these two tubes, in the case of the water-pipe C, there is a washer of rubber or leather to keep the joint from leaking. In the case of the outlet air-pipe D the arrangement adopted is shown in figure 2. Between the tubes R and S, there there is a cork washer V,* cut, as shown in the figure, so that part of it enters in the tube S, while another portion is pressed between the tube R and the rim of tube S. To the face of this cork washer, which is turned towards R, is stitched a soft rubber washer W, about $\frac{1}{16}$ of an inch thick, its diameter being the same as that of the wide part of V. This rubber washer has a hole in its center about $\frac{3}{16}$ of an inch diameter, while the cork washer has a hole of $\frac{1}{8}$ of an inch diameter.

At the end of the tube R furthest from the screw, a wire is placed on the diameter of the tube and riveted in its place. This wire is to prevent the weight U from falling further down, when placed as shown in the figure 2. This weight is cylindrical, with a hemispherical head at the end, which is turned towards the washer W. The diameter of the weight is slightly smaller than that of the interior of the tube R, that it may move in this tube with ease. The rounded end of this weight is polished, but the cylindrical portion may remain quite rough. The cylindrical portion has two deep grooves, to let the air pass freely from below the weight to the space above it. The function of this cylindrical weight is to close the opening left in the thin rubber washer W. This is easily understood by reversing figure 2, so that the tube R shall be above the tube S, in which case the weight U slips down and closes the opening in the thin rubber washer. The cylindrical weight U is made of an alloy of lead and antimony, which gives sufficient density, combined with hardness. The length of each cylindrical weight is $1\frac{3}{4}$ inches, the diameter being $\frac{1}{2}$ inch. Each one weighs 3 ounces.

An indispensable condition for the proper working of this valve is that the opening in the rubber washer W shall be in the axis of the tube

* As cork and rubber are not sufficiently durable, the washer V should be of hard wood, and the washer W of leather. Another leather washer should be inserted between V and S.

R, as otherwise the weight U will not close this opening perfectly. It is to insure this condition, that a portion of the cork washer V has been given a smaller diameter; that it may be inserted in the tube S, and be kept from moving sideways. By attaching the thin rubber washer to this cork washer by a few stitches of thread, the rubber washer is kept immovable in its proper place.

The arrangement shown in figure 2 is, as I have said, the one adopted at each end of the outlet air-pipe D, the tube R being soldered on the drum. In the case of the inlet air-pipes, E and F, the tube S has been suppressed, and the cork washer is of sufficient diameter to fit in the nut T. The rubber washer is stitched on its under side, as before.

Constant Pressure.—By referring to figure 1, we may notice that the inlet air-pipes, E and F, are prolonged to nearly the bottom of their respective drums. The object of lengthening these pipes is to insure constant pressure to the blast.

In the positions of things shown in figure 1, the pipe F is closed, but the pipe E is open, and it may be seen that the drum A is equivalent to a *Mariotte's flask*, and the water pressure is represented by the distance from the lowest part of E to the outlet of the water-pipe. In the apparatus which I now exhibit before the society, this height is equal to 15 inches, equivalent to nearly 10 ounces pressure per square inch. Each drum in this apparatus has a diameter of 10 inches, and a height of 8 inches.

The duration of the blast depends on the bore of the nozzle. For the small bore used in qualitative blow-pipe tests, the drums have to be reversed every 35 minutes. For the bore used in Plattner's quantitative assays, the duration is 20 minutes. For a large flame, fit for glass blowing, using a bore equal to No. 22 wire gauge, the duration is 12 minutes.

Spring catch.—A necessary feature of this apparatus is a spring-catch, to hold the drums in position while working. Without it, the upper drum when full of water, would not remain above the lower. This catch is freed by pressing on a button when the drums are to be reversed. The operation of reversing takes about a second. As a spring catch is very easy to make, no detail is given of it in the figure.

Water-trap.—When there is too much water in the drums, and under other conditions, which I have not been able to determine, a little water sputters up with the air, and finds its way to the blow-pipe. To prevent this, a trap is conveniently made, as in figure 3, with a glass tube tightly closed at each end by a rubber cork. A tube enters through the middle of each cork, one for the ingress of air from the lower drum, and the other for its egress to the blow-pipe. One of the corks is provided with another hole, near its circumference, which may be conveniently closed

with a plug of any hard substance, and water may be let out from time to time, by removing this plug. In the bellows I use, the glass tube shown in figure 3 is placed in the hollow journal H.

Fig 1.

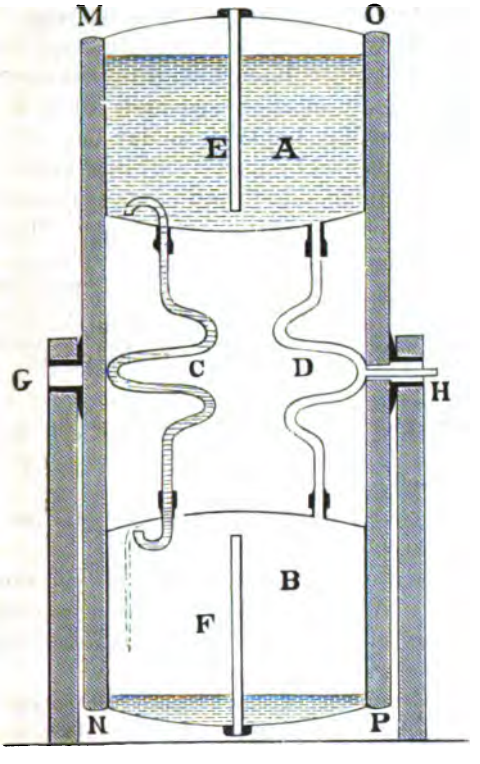


Fig 2.

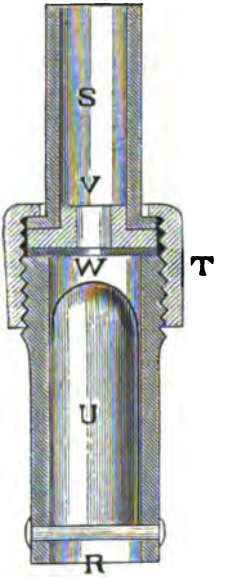
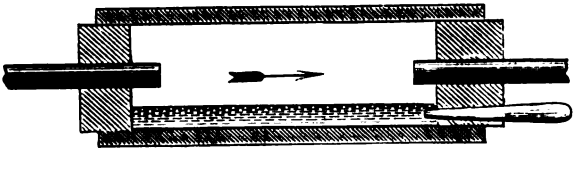


Fig 3.



VIII.—Proceedings.

Regular Meeting, March 7th, 1878.

The meeting was called to order at 8.15 P. M., Dr. Chandler in the chair. The minutes of the previous meeting were read and approved.

The Board of Directors reported as follows: At a meeting of the Board of Directors, held March 7th, 1878, it was resolved to approve the action of the Committee on Rooms, with reference to its rental of the room in 14th street, at an annual rental of $700, up to May 1st, 1878, and $800 from May 1st, 1878, to May 1st, 1879. The Treasurer was authorized to pay said rent monthly in advance; also, to receive from authors voluntary contributions in payment for cuts furnished for vol. I, part 2d of the proceedings. The Committee on Papers and Publications was authorized to accept and print papers from non-members, also to have two additional numbers of the proceedings printed. The matter of purchasing the library of the late Dr. I. Walz was referred to the Librarian.

The following were elected:

As members—W. H. Baker, C. E. Colby, H. S. Munroe; *as associate*, W. P. Prentice.

The following were proposed:

As members—F. M. Rogers, W. Chandler Roberts, J. P. Carson; *as associate*, George Harding.

The papers announced for the evening were read: On the Oxidation of Xylenesulphonic Acids, by Malvern W. Iles, and Contributions to the Chemistry of the American Grape Vine, by C. A. Goessmann.

Prof. Chandler showed specimens of the Photo-electrotype Process, in which negatives are taken from pen and ink sketches and exposed on bichromate-gelatine, which, after exposure and washing, is transferred to metal by taking first a wax mold and then preparing an electrotype..

Mr. Parker inquired whether any member had any experience in the application of ammoniacal copper solution to the determination of free acids in acid salts, especially those of iron and alumina.

Adjourned.

M. ALSBERG,
Recording Secretary.

IX.—Contribution to the Chemistry of the American Grape Vine.

BY PROFESSOR C. A. GOESSMANN.

The question, whether a systematic and rational manuring of our fruit-bearing plants is essential for the continued production of good crops engages of late, deservedly, our increased attention. It seems but reasonable to assume, that the same practice which has been recognized as indispensable for success in general agriculture ought to apply with equal force to the operations in fruit culture, and horticulture in general. Modern rational agriculture bases its claim of superior progress, as compared with preceding periods, on the recognition and application of the principle, that it is essential for the continued success of its industry to return to the soil those substances which the crops abstract. It has been one of the principal occupations of numerous scientific investigators of agricultural problems, during the past thirty years, to prove the existence of these relations, and to study how to comply best with their requirements in an economical manner. Most of our common farm crops have received, from the beginning, an undivided and careful attention: their composition has been ascertained, and their action on the soil thereby established. In many instances, their peculiar mode of growth has been studied, to learn in what form the various manures are best applied in cases of different kinds of soil. Nobody familiar with the results of the investigations of late years, can fail to notice their extraordinary influence on the progress of agricultural practice. The same statement cannot be made with reference to fruit culture and horticulture. Experiment-stations for the benefit of these branches of agriculture are but few, and these, in the majority of instances, of a very recent date. Superior skill and intelligence have been largely engaged in the promotion of their interests from an exclusively botanical stand-point; while the peculiar intricacy of the subject, the growing of plants with a view of producing crops with reference to a certain quality rather than to mere quantity, may account, to some extent at least, for the comparatively limited practical interest, which, until of late, most horticulturists have manifested in trying chemistry as an assistant in their industry.

There is no scarcity of valuable observations regarding an exceptionally good success in producing fruits by the aid of various kinds of fertilizers; yet it is no less well recognized that but little satisfactory explanation can be given as to the particular relations which exist between the composition or the quality of the fruit, and certain constituents and the condition of the fertilizer used. The chemical composition of the majority of fruits is but imperfectly known. The question,

whether the ash constituents of the fruit bear more than a mere incidental relation to the quality, is still largely a matter of conjecture, which derives its main support from the fact that the ash constituents of a few of our cultivated varieties, for instance, in the case of the strawberry, have been found widely differing, in regard to quantity and to quality, from those found in the wild forms from which they have originated. No important inferences have thus far been drawn from these observations.

Numerous careful inquiries into the composition of many of our farm crops have shown that the total amount of the mineral or ash constituents of one and the same variety of plant may vary widely in different specimens, when raised upon different soils, or under otherwise varying conditions of cultivation.

Experimental observation has thus far failed to prove the existence of any definite numerical relation between the total quantity of the essential mineral or ash constituents, and of the entire dry organic matter of plants. We have learned that certain, and, comparatively speaking, but a few mineral elements are essential for the complete development of plants; yet we have only very vague notions regarding their peculiar mode of action in the process of vegetable growth. While we are ignorant, thus, of the peculiar mode in which these mineral constituents assist in the formation of organic matter, we have noticed, in the case of some of our most important industrial farm crops, that a more or less liberal supply of certain essential articles of plant food, as potassa, nitrogen, &c., quite frequently exerts a remarkable influence on the general character of the quality of the crops resulting, as far as the relative proportion of some of their proximate organic constituents, as albuminoids, starch, or sugar, is concerned. Even the peculiar form in which potassa, &c., have been applied, is known to exert, in many instances, a decided influence on the larger or smaller production of one or the other organic constituents of plants. The recent history concerning the safest modes of raising industrial crops of a superior quality for the purpose they shall serve, deserves, in my opinion, the serious attention of fruit culturists in particular.

Judging from our past experience in general farm management, it seems proper to assume that much benefit may be secured to fruit culture and horticulture by studying the relations which exist between the composition of the soil and the ash constituents of the fruits grown upon it. A rational system of manuring the fruit-bearing plants requires that kind of information for its foundation. It is quite certain that the practice of restoring to the soil, in suitable form and in due time, those constituents which the fruits abstract, cannot but contribute towards large crops by stimulating a vigorous condition of the entire plant. A strong,

healthy plant is quite naturally better qualified to overcome interior local disorders, and to resist more successfully external injurious influences, than feeble specimens. Considering the previously expressed views worthy of serious attention, I have, of late, instituted a series of field experiments with grape vines, for the purpose of testing the action of certain special fertilizers on their productiveness, as far as quantity and quality of the grapes are concerned, and to ascertain whether a favorable change in their quality is accompanied with a definite alteration in the relative proportion of their mineral or ash constituents. I selected, for reasons already stated in previous communications,* the fruits of a cultivated and of a wild native variety of grape vine, namely, the

CONCORD GRAPE AND THE WILD PURPLE GRAPE (*Vitis Labrusca, L.*)

A due appreciation of the expected results, rendered it quite advisable to study previously some of the more prominent features in the growth of these grapes, without any application of manure. As but little has been published regarding the chemical composition of our native grapes, I propose to describe subsequently some observations made in that connection, which, in my opinion, are of a more general interest from a scientific as well as a practical stand-point. My particular thanks are due to Professor S. T. Maynard, and to Messrs. E. B. Bragg and W. P. Brooks (graduates of the College, of the class of 1875), for very efficient assistance rendered in the progress of the investigations. Professor Maynard has taken a very active interest in the field work; and Messrs. Brooks and Bragg have very satisfactorily carried out, under my direction, most of the analytical work.

ON THE GROWTH AND COMPOSITION OF GRAPES.

The examination was confined, in the majority of cases to the berries and the juice of the grapes. The former were tested for the amount of water they lost at 100° C., and the total dry matter they left behind at that temperature. The juice of the grapes, obtained after crushing by means of a hand press, was examined for its specific gravity, its percentage of grape sugar, and its free acid. The sugar was determined by Fehling's mode, after the juice had been treated with an equal volume of a solution of basic acetate of lead, of the same concentration as that usually applied for the defecation of the juice of sugar-beet roots. The amount of free acid was determined with a solution of pure carbonate of soda, containing one gramme of calcined soda in one hundred cubic centimeters of the solution, and the test finished by finally raising

* See Thirteenth Annual Report of the Massachusetts Agricultural College, p. 60, and also the Massachusetts Ploughman of June 24, 1877.

the temperature to near the boiling point. The examination of both berries and juice was repeated in various important stages of the development of the grapes. Ash analyses have also been carried out as far as time has thus far permitted; yet, as only a small number of the analyses of the ashes of the berries has been finished, a more detailed discussion of the results obtained will have to be deferred to some future suitable occasion. The relative amount of acid has been reported for the present, only to secure more exact quantitative statements after the nature of the acid has been more thoroughly studied.

Concord Grape. (Not fertilized.)

Date.	Specific Gravity.	Temperature Centigrade.	Moisture lost at 100°-110° Centigrade.	Percentage of dry matter at 100°-110° Centigrade.	Percentage of grape sugar in the juice.	Percentage of sugar in solid dry matter.	Amount in cu. cent. of soda solution to neutralise 100 parts juice.
1876.							
July 17..	1.0175	31°	91.70	8.30	0.645	7.77	
" 20..	1.0150	31°	91.90	8.10	0.625	7.72	216
Aug. 2..	1.0200	25°	90.06	9.94	0.938	9.44	249
" 16..	1.0250	28°	89.12	10.88	2.000	18.38	229
" 30..	1.0500	25°	84.42	15.58	8.62	55.33	120
Sept. 13..	1.0670	23°	82.52	17.48	13.89	79.46	55
" 4..	1.0700	18°	80.18	19.82	16.13	81.38	49.2

Purple Wild Grape. (Near Adams's Pond.)

July 19..	1.020	31°	91.00	9.00	0.714	7.93	204
Aug. 4..	1.020	28°	87.75	12.25	1.10	8.98	249
" 16..	1.025	28°	87.52	12.48	2.00	16.03	233
" 30..	1.050	26°	83.42	16.58	6.50	39.81	147.6

White Variety of Wild Grape. (Near the purple grape.)

Aug. 31..	1.050	26°	83.52	16.48	9.26	56.18	98

The juice of the Concord grape collected on the 17th of June, as above stated, was watery and of a yellowish-green color: it turned purple by heating with a slight excess of either ammonia or potassa, showing that the coloring matter, which is characteristic of the ripe grape, is already, in some concealed form, present at a very early stage of its growth. The wild purple grape, in a similar condition of growth, showed the same property, with the exception that its juice was of a

viscid character, and its color of a deeper tint when rendered alkaline. The color peculiar to these grapes makes its first appearance in the stems of the berries, and passes then rapidly on to the outer tissues of the skin. During the season of 1876, this change became first noticeable about the middle of August; and on the 30th of the month the color had already increased to such an extent, that a solution of basic acetate of lead produced a light purple-blue precipitate, similar in color to a freshly precipitated hydrate of chromium oxide. It will be noticed from the above tabular statement, that with the middle of August began a remarkable change in the growth of the grape. The free acid became most prominent in the juice about the first week in August, sank to less than one-half of its quantity towards the close of that month, and amounted, at the beginning of October, to one-fifth only of the largest quantity noticed in August. The sugar began to increase in the juice about the same time, when the free acid had reached its highest amount, and when the chlorophyll began to suffer a transformation of its green color into a purple pigment: its increase was, however, in a much larger ratio than the decrease of the free acid. A test of the entire berry for free acid, made on the 20th of July, but one week before the highest percentage was observed in the juice, showed that all the free acid noticed at that period in the berries was in solution in the juice; while repeated tests made with entire berries, and also with their juice, after the free acid in the latter had considerably fallen off, proved the presence of a larger amount of free acid in the berries than in the juice, which demonstrated the fact that the smaller quantity of free acid found in the juice of the grapes at a more advanced state of growth is due, in part at least, to the circumstance that the acid has partly formed quite insoluble acid combinations with potassa and with lime, which are largely distributed, in a crystalline form, through the cellular mass, and thereby cause a less acid reaction of the juice. In consideration of these observations, it seems but reasonable to conclude that Liebig's view, which assumes a conversion of the acid of the grapes in the later stages of their growth into grape sugar, does not agree with our present information. Dr. Neubauer, in his interesting investigation of German grapes, came to similar conclusions. He favors, besides, the opinion that a periodical increased access of potassa and lime into the fruit, causes the mentioned alterations at the stated stage of development. I shall return to this subject when discussing the relation of the ash constituents in different stages of growth to the periodical changes in the composition of the fruit. A careful test made with the sap of grape-vines, taken in the month of May, from an incision in the vine, made from about four to five feet above the ground, proved the absence of both cane and grape sugar in that liquid. Comparing the above

reported results of the comparative tests carried out with the juice of the wild purple grape and that of its cultivated offspring, it becomes at once noticeable, that, as far as the present investigation has been extended, their main difference, from a chemical stand-point, consists in changes regarding the quantity of sugar, the amount of total soluble matter, and the intensity of color. The acid, it seems, has not been affected. The sugar increases, during the last period of ripening, but little, and apparently partly from concentration of the juice by loss of moisture. Once removed from the grape vine, the grapes lose moisture quite rapidly at ordinary temperatures, yet at different rates, as may be seen from the following statement:

Percentage of moisture lost.	Concord.	Agawam.	Israella.	Delaware.
Within eight days.....	9.97	10.80	11.74	8.75
" two weeks.....	9.97	17.76	11.74	14.41
" three weeks.....	20.53	24.89	27.54	19.87
" four weeks.....	26.75	31.12	35.62	24.52

The aromatic principles beome more prominent at the close of the ripening process, in all probability in consequence of a reaction of the albuminoids on the grape sugar. They consist usually of combinations of alcohols with fatty volatile acids (compound ethers).

ON THE COMPOSITION OF VARIOUS KINDS OF CULTIVATED RIPE GRAPES.

The subsequent statements comprise the observations of 1876 and and 1877: the specimens which served for tests—with the exception of the Catawba, the Isabella, the Eumelan, the first-named Hartford Prolific, and the wild varieties—came from the College vineyard, and were as nearly as possible of the same degree of ripeness.

Hartford Prolific.

(Obtained through the kindness of H. Kendall, Esq., Providence, R. I.)

Date.	Specific Gravity.	Temperature Centigrade.	Moisture lost at 100°–110° Centigrade.	Percentage of dry matter at 100°–110° Centigrade.	Percentage of grape sugar in the juice.	Percentage of sugar in solid dry matter.	Amount in cu. cent. of soda solution to neutralize 100 parts juice.
1876.							
Sept. 5..	1.06	22°	82.61	17.39	13.89	79.87	88.8

Ives' Seedling.

Date.	Specific Gravity.	Temperature Centigrade.	Moisture lost at 100°–110° Centigrade.	Percentage of dry matter at 100°–110° Centigrade.	Percentage of grape sugar in the juice.	Percentage of sugar in solid dry matter.	Amount in cn. cent. of soda solution to neutralize 100 parts juice.
Sept. 6..	1.07	26°	79.85	20.15	15.15	75.14	88.6
Iona.							
Sept. 7..	1.08	21°	75.44	24.56	15.15	61.68	144
Iona. (Mildewed.)							
Sept. 7..	1.045	26°	85.59	15.41	6.25	40.56	204.4
Agawam.							
Sept. 11..	1.075	20°	79.21	20.79	17.24	82.92	94.8
Wilder.							
Sept. 11..	1.064	20°	83.47	16.53	13.67	82.69	56
Delaware.							
Sept. 12..	1.08	24°	76.51	23.47	17.86	76.09	74
Charter Oak.							
Sept. 12..	1.08	24°	84.02	15.98	8.77	54.94	168.3
Israella.							
Sept. 16..	1.075	23°	80.33	19.67	9.20	46.77	89.8

Bent's Seedling.

Date.	Specific gravity.	Temperature Centigrade.	Moisture lost at 100°-110° Centigrade.	Percentage of dry matter at 100°-110° Centigrade.	Percentage of grape sugar in the juice.	Percentage of sugar in solid dry matter.	Amount in cu. cent. of soda solution to neutralise 100 parts juice.
Sept. 20	1.08	21°	78.35	20.65	16.13	78.11	181.8

Adirondack.

Sept. 20	1.065	21°	84 89	15.11	13.17	87.16	68

Catawba. (From New York.)

Oct. 16	1.08	13°	76.55	23.45	17.39	74.16	82

Wilder.

1877. Sept. 11	1.065	23°	83.59	16.41	15.15	92.32	60

Charter Oak.

Sept. 12	1.055	23°	83.78	16.22	9.80	60.42	96

Concord.

Sept. 13	1.065	24°	84.10	15.90	13.16	82.76	102
" 26	1.075	24°	80.66	19.34	15.43	79.78	70.8

Eumelan.

Sept. 24	1.065	16°	80.38	19.62	13.16	67.07	73

Wild White Grape. (Ripe, yet not shriveled.)

Date.	Specific gravity.	Temperature Centigrade.	Moisture lost at 100°-110° Centigrade.	Percentage of dry matter at 100°-110 Centigrade.	Percentage of grape sugar in the juice.	Percentage of sugar in solid dry matter.	Amount in cu. cent. of soda solution to neutralize 100 parts juice.
Sept. 5	1.050	22°	84.43	15.57	7.20	46.24	140.8
		(Specimen much shriveled.)					
" 20	1.060	16°	79.98	20.02	10.00	49.95	130

Wild Purple Grape. (Near Adams's Pond; was shriveled.)

Sept. 20	1.045	16°	83.69	16.69	8.22	49.25	104

The different kinds of grapes above mentioned behaved, in many instances, quite remarkably unlike each other in regard to the action of their juice towards basic acetate of lead. The latter produces in every case a voluminous, colored precipitate; yet these colors seem to result from the presence of several distinctly different pigments in the grapes, peculiar, in all probability, to the wild native varieties from which our cultivated ones have been produced. This re-action may prove of practical use as an aid in tracing the relationship to each other of the different varieties of grapes under cultivation. Dr. G. Engelmann, in his excellent description of the true American grape vines, incidentally states that some growers consider the Delaware and the Clinton as derived from the same wild variety Riverside grape (*Vitis riparia*, Mich.), which appears doubtful, judging from the reaction with basic acetate of lead; for the juice of the Delaware grape gives a cream-colored precipitate, while that of the Clinton produces a bluish-green colored one, indicating quite different pigments in these varieties. As this peculiarity of the different kinds of grapes may be of interest to some cultivators, I will state some of my results in this direction. The reactions are all made with ripe grapes, if not otherwise stated.

Purple Wild Grape.
Hartford Prolific.
Concord.
Wilder.
Ive's Seedling.
Israella.
Isabella.
Clinton.

} From light purple and bluish-green to slate color.

White Wild Grape. Iona. Delaware. Charter Oak. Eumelan. Agawam.	From bright sulphur-yellow to cream-color.

Whether the various tints of the precipitates are due to the combination of the two extremes, dark purple and light sulphur-yellow, or to the result of a peculiar physiological process in the different varieties, is a question which only more detailed inquiries can decide.

INFLUENCE OF GIRDLING THE VINES ON THE GROWTH AND COMPOSITION OF GRAPES.

The current statements regarding the effects of girdling grape vines on the quality of the grapes growing on such plants, are quite contradictory. To obtain some more definite idea concerning this practice, a series of experiments was planned, and, with the kind assistance of Professor S. T. Maynard, carried out during the past season. The vines were girdled during the first week of August,—about the time when the berries of the Concord grape had reached the point when the free acid had attained its highest development, and the grape sugar had begun slowly to increase. Entire vines, as well as large branches, served for the trial. Two incisions, from one-eighth to one-fourth of an inch apart, were made through the bark and the cambium layer, and the mass between these cuts, down to the wood, carefully removed. A decided difference in the degree of growth of the grapes began soon to be noticeable, and to manifest itself during the entire season, until the grapes on the girdled branches had just reached their ripeness. The tests made at this point, with both the grapes of the girdled and of the ungirdled branches, grown upon the same vine, showed quite a remarkable difference in the general quality of the entire grape and in their relative degrees of development. In some instances, it can be safely said that the girdled branches were from two to three weeks in advance of the ungirdled ones. A careful comparison of the previously described rate of growth of the Concord grape can serve as a proof of this statement. Some of the subsequently described analytical results do not as decidedly prove the great difference, because the tests were carried out a few days later than they ought to have been, which gave a good chance for the grapes from the ungirdled branches to gain time on the grapes from the girdled branches, which, being ripe, had reached a period of but very slow change in composition. The analytical statements below, concerning the Concord grape, show, also, that a ripe

grape does not improve when kept too long on the vine. The sugar decreases apparently, and the acid increases (most likely on account of the formation of some acetic acid); the taste becomes, by degrees, more indifferent. The girdled vines did not show the slightest difference when compared, at the close of the season, with the ungirdled. The place where the bark had been removed was grown over. The plants which served for the experiments will be watched during the coming season, to learn whether any serious after-influence may show itself. It s also intended to find out what effect girdling will exert on grapes and juice when carried out at other periods of their growth.

RESULTS OF GIRDLING GRAPE VINES.

Hartford Prolific. (Branch not girdled.)

Date.	Specific gravity of juice of berries.	Temperature Centigrade.	Moisture lost at 100°-110° Centigrade.	Percentage of dry matter at 100°-110° Centigrade.	Percentage of grape-sugar in the juice.	Percentage of sugar in solid dry matter.	Amount in cu. cent. of soda solution to neutralise 100 parts juice.
1877.							
Sept. 3	1.045	19°	87.15	12.85	8.77	68.25	111.4
			Girdled Branch.				
" 3	1.065	19°	82.82	17.18	12.50	72.76	100

Wilder. (Branch not girdled.)

Sept. 3	1.055	19°	84.59	15.41	10.42	67.62	108.2
			Girdled Branch.				
" 3	1.075	19°	82.76	17.24	14.70	85.26	88.4

Delaware. (Branch not girdled.)

Sept. 4	1.065	19°	84.25	15.75	11.76	74.66	101.2
			Girdled Branch.				
" 4	1.075	19°	80.86	19.14	15.15	79.16	94.4

Agawam. (Branch not girdled.)

Date.	Specific gravity of juice of berries.	Temperature Centigrade.	Moisture lost at 100°–110° Centigrade.	Percentage of dry matter at 100°–110° Centigrade.	Percentage of grape sugar in the juice.	Percentage of sugar in solid dry matter.	Amount in cu. cent. of soda solution to neutralize 100 parts juice.
Sept. 4	1.060	19°	83.40	16.60	11.37	68.48	128.2
			Girdled Branch.				
" 4	1.075	19°	81.55	18.45	16.31	87.42	114.8

Iona. (Not girdled.)

Sept. 6	1.0625	22°	80.37	16.60	13.51	68.31	131.4
			Girdled Branch.				
" 6	1.085	22°	78.52	21.48	15.63	72.76	125.6

Concord. (Branch not girdled.)

Sept. 6	1.045	22°	86.54	13.46	7.46	55.42	182.4
			Girdled Branch.				
" 6	1.070	22°	82.47	17.53	13.88	79.18	102.8
			Branch not girdled.				
" 26	1.065	22°	82.37	17.63	13.70	78.27	86.
			Girdled Branch.				
" 26	1.080	22°	75.53	24.47	19.61	80.13	76.8
			Branch not girdled.				
Oct. 5	1.075	12°	79 08	20.92	17.50	85.37	42.
			Girdled Branch.				
" 5	1.085	12°			17.86		54.

ON THE MINERAL CONSTITUENTS OF THE CONCORD AND THE WILD PURPLE GRAPE VINES.

In a previous report (1876) I have already stated the ash analyses of several parts of the Concord grape; namely, that of the seeds, of the stems, and of the skins of the grapes, of the young and old woods, besides that of the fresh and fermented grape juice. In the present communication I propose to add the following analytical results:

I.—Analysis of the young branches, with their tendrils and blossoms, of the Concord vine.

II.—Analyses of the berries, without their stems, of the Concord vine, in different stages of their growth.

III.—Analyses of the berries of the Concord grape raised with the assistance of a special fertilizer, and of those raised without any fertilizer, upon the same field.

IV.—Analyses of the berries of the Wild Purple grape, without stems, grown in the woods near Adams's Pond, and of those transplanted from that locality to the college vineyard, and there treated with the same fertilizer as the Concord grape vine mentioned above in No. 3.

As the investigation is still going on, it is thought best to defer a detailed discussion of these quite interesting results to a future occasion, when the work pointed out in the introduction may be considered more satisfactorily accomplished. As the peculiarity of the season must, quite naturally, be considered an important agency in controlling the results of growth, it is most desirable that certain tests should be repeated for several years, to impart more reliability to the conclusion drawn from all facts and circumstances which bear on the question under discussion.

Thus far the results obtained with one fertilizer only have been examined. This fertilizer, which I have called No. 1 in my experiments, contains one pound of nitrogen in form of nitric acid, to three and one-half pounds of potassium oxide in the form of potassium nitrate, and two and one-quarter pounds of soluble phosphoric acid, prepared from bone-black waste. The amount per acre is compounded of one hundred and eighty pounds of potash nitre, and four hundred and fifty pounds of a superphosphate containing twelve per cent. of soluble phosphoric acid. In the analysis, to obtain a material of exact comparative value, I converted the carefully prepared ash constituents into sulphates, subsequently determined the sulphuric acid, and calculated in the remaining saline matter the various constituents for one hundred parts. The silicic acid has not yet, in every case, been controlled by a re-solution, and is therefore included with the incidental insoluble matter under that name.

I.—Young branches, with tendrils and blossoms, of the Concord grape vine, collected on the 15th of June, 1876:

Moisture lost at 100°–110° centigrade	80.80 per cent.
Dry matter	19.20 "

One hundred parts of their ash contained:

Potassium oxide	24.7102 per cent.
Sodium oxide	.9442 "
Calcium oxide	40.5302 "
Magnesium oxide	10.6611 "
Ferric oxide	1.0773 "
Phosphoric acid	17.1590 "
Matter insoluble in dilute hydrochloric acid	5.5705 "

II.—Berries of Concord, without stems, and not fertilized:

(*a*) Berries collected on the 7th of July, 1876.
(*b*) Berries collected on the 17th of July, 1876.
(*c*) Berries collected on the 18th of August, 1876.
(*d*) Berries collected on the 13th of September, 1876.

——	(*a*)	(*b*)	(*c*)	(*d*)
Potassium oxide	41.73	47.34	51.14	57.15
Sodium oxide	5.04	1.13	3.19	4.17
Calcium oxide	25.03	24.21	16.20	11.30
Magnesium oxide	7.80	To be redetermined.	6.38	3.10
Ferric oxide	0.55	.75	.65	.40
Phosphoric acid	18.48	21.38	20.77	12.47
Insoluble matter	1.37	.43	1.67	11.82

III.—Berries of the Concord grape, without stems, raised upon the ground, *fertilized* as stated above, and collected on the 3d of October, 1877:

Potassium oxide	64.65 per cent.
Sodium oxide	1.42 "
Calcium oxide	9.13 "
Magnesium oxide	3.63 "
Ferric oxide	.50 "
Phosphoric acid	14.87 "
Insoluble matter	5.80 "

IV.—Berries, without stems, of the Wild Purple grape:—

(*a*) Berries collected on the 13th of September, 1876, from a wild vine near Adams's Pond.

(*b*) Berries collected on the 20th of September, 1876, transplanted to the college grounds, and fertilized as stated above.

	(*a*)	(*b*)
Potassium oxide	50.93	62.65
Sodium oxide	.15	.85
Calcium oxide	22.23	14.24
Magnesium oxide	5.59	3.92
Ferric oxide	.79	.53
Phosphoric acid	17.40	13.18
Insoluble matter	2.93	4.63

EFFECTS OF CULTIVATION AND FERTILIZATION ON THE COMPOSITION OF SOME WILD VARIETIES OF GRAPES.

Analyses of Wild White and Purple grapes:—

(*a*) Berries of Wild White grape, without stems, from near Adams's Pond, collected on the 20th of September, 1877. (Dead ripe.)

(*b*) Berries of Wild White grape, without stems, from college vineyard, treated with fertilizer No. 1. Collected 20th of September, 1877. (Dead ripe.)

(*c*) Berries, without stems, of Wild Purple grape, from Adams's Pond. Collected 20th of September, 1877. (Dead ripe.)

(*d*) Berries, without stems, of Wild Purple grape, treated with the above stated fertilizer. Collected 20th of September, 1877. (Dead ripe.)

Specific Gravity.	Temperature Centigrade.	Moisture lost at 100°-110° Centigrade.	Percentage of dry matter at 100°-110° Centigrade.	Percentage of grape sugar in the juice.	Percentage of sugar in solid dry matter.	Amount in cu. cent. of soda solution to neutralize 100 parts juice.
			(*a*)			
1.060	16°	79.98	20.02	10	49.95	130
			(*b*)			
		78.35	21.65	14.29	65	65
			(*c*)			
1.045	16°	83.31	16.69	8.22	49.25	104
			(*d*)			
1.065	16°	80.45	19.55	13.67	69.92	121.6

These analyses show very decidedly the influence of mere cultivation on wild varieties. Further investigations in this direction are in progress.

THE AMERICAN CHEMICAL SOCIETY.

X.—Proceedings.

Regular Meeting, Thursday, April 4th, 1878.

Vice-President Casamajor in the chair. The minutes of the previous meeting were read and approved.

The following were elected:

As Members—F. M. Rogers, W. Chandler Roberts, J. P. Carson; *Associate*, G. Harding.

Prof. Goessmann's papers were read by title and ordered to be printed.

Dr. Mott read a paper "On the application of Polarized Light for the Examination of the Alkaloids of the Quinine group," giving the results of qualitative and quantitative experiments on the behavior of the alkaloids of the quinine group in polarized light. In the discussion, that followed, the use of Laurent's improved modification of Soleil's saccharometer, using monochromatic light, was recommended. The objection to this is, that it is very tiresome to the eye, and for this reason Mr. Casamajor stated, that the sodium light is not reliable, the best results only being obtained with ruby glass.

Mr. J. Lawrence Smith stated, that, the process in the arts for the separation of the quinine alkaloids being almost perfect, Dr. Mott's method for the determination of their respective quantities must be highly welcome.

Mr. Stillwell read a paper "On the Estimation of the precipitated or reduced Phosphoric Acid in Superphosphates." The methods, employed by different analysts, vary so greatly, that it is impossible to obtain uniform results, therefore it is very desirable that the analysts, of this country at least, should come to an understanding regarding the estimation of reduced phosphoric acid. Several members corroborated Mr. Stillwell's statements and all agreed, that the results varied with the methods employed.

Mr. J. L. Smith then entertained the society with a brief statement of the results of his examination of the columbites and tantalites, and of Greenland basalts. Samarskite contains no thorium oxide, but an oxide from the cerium group, being precipitated by silver and potassium sulphate; it can be separated by fractional precipitation of the oxides, and must be terbium or a new metal.

Mr. Smith has made an approximate estimation of its atomic

weight. He has sent some to Marignac, who has recently found Tb in gadolinite.

In the course of his investigations, Mr. Smith found that thorium can be separated from cerium by treating the oxides with Cl in an alkaline solution, when only Th is dissolved, which can be precipitated by NH_3.

The best method to attack columbites and tantalites is with hydrofluoric acid, which shortens the process considerably.

The arrangements for the second anniversary of the society were left to the Committee on Conversazione.

The following were proposed:

As Members—E. Calder, Providence, R. I.; D. Suthy, Philadelphia.

As Associates—E. D. Weston, N. Y.; D. D. Williamson, N. Y.

Dr. Chandler made the following motions:

Resolved, That the Secretary be directed to present to the Trustees of the College of Pharmacy, the thanks of this society for their generous hospitality in granting to us the use of their lecture room, and our congratulations on the continued prosperity of the College, and on their recent acquisition of a new building, which will afford them greater facilities for the expansion of their most useful work in affording an education to pharmacists.

Resolved, That the Treasurer be directed to request the permission to pay for the gas consumed, and for any other expenses which attended the use of the lecture room by this society.

Carried unanimously.

Adjourned.

M. ALSBERG,
Recording Secretary.

XI.—Report on recent Experiments with Sugar-cane in Louisiana.

BY PROF. C. A. GOESSMANN.

The most interesting feature of these experiments consists in the circumstance, that they were planned with the design to ascertain the effects of various compositions of fertilizers, with reference to both quantity and quality of the cane raised by their assistance. The fact, that the polariscope has been used on that occasion, for the first time for that purpose, upon the plantations of Louisiana, deserves particular notice. The results being based only on two years' experimenting, are quite naturally not decisive; yet they derive already an unusual interest from the fact, that they furnish an excellent chance to the sugar manufacturers

in Louisiana, to learn with what success they have been able during the past to secure a fair percentage of the sugar contained in the cane they have been raising. Knowing once with approximate certainty the amount of sugar which the growth of one acre contains, intelligent attempts to secure the largest percentage possible will not long be delayed. The prospects are, therefore, that by continuing their intelligent course of investigation, a more rational system of fertilization, supported by an improved mode of separating the sugar, will soon richly repay the expenses incurred. One of the plantations which served for the experiments, is owned by Daniel Thompson, Esq., of Bayou Teche, in the parish St. Mary; and the other one belongs to Thomas M. Caje, Esq., of Houma, in the parish Terrebonne. The land used for the trial was in both instances carefully selected and suitably prepared for the work; each experimental plot consisted of one acre in size.

I.—Mr. Daniel Thompson's Experiments (1876).

TABLE A.—PLANT CANE—ELEVEN PLOTS.

No. of Plot.	Material used as Fertilizer.	Quantity used, in pounds.	Quantity of soluble constituents of the Fertilizer.	Weight of the Cane raised, in pounds.	No. of gallons of cane juice.	Result of Polarization apparatus.	Total amount of Sugar available, in pounds.
1	Animal matter.....	450	Phosphoric Acid, 56. lbs..				
			Ammonia, 56.5 lbs.....	44,340	2955	10.1	2635
2	Animal matter.....	450	Phosphoric Acid, 56. lbs..				
			Ammonia, 38. lbs..,.....	38,560	2665	10.5	2463
3	Cotton Seed Meal.....	400					
	Sulphate of Ammonia..	100	Ammonia, 58. lbs.....				
	Acid Phosphate of Lime	221	Phosphoric Acid, 55. lbs..	51,700	3862	10.	3406
	Nitrate of Potassa.....	86	Potassium Oxide, 40. lbs..				
			Nitric Acid, 45. lbs.....				
4	Sulphate of Lime.....	313	Lime, 102. lbs.....				
	Sulphate of Ammonia..	223	Ammonia, 56. lbs.....	50,450	3532	9.3	
			Nitric Acid, 89. lbs.....				
	Nitrate of Potassa.....	178	Potassium Oxide, 80. lbs..				
	Acid Phosphate of Lime	357	Phosphoric Acid, 64.5 lbs.				
5	Acid Phosphate of Lime	321	Phosphoric Acid, 40. lbs..				
	Sulphate of Ammonia..	160	Ammonia, 40. lbs.....				
	Nitrate of Potassa.	86	Potassium Oxide, 40. lbs..	57,200	4050	9.5	
			Nitric Acid, 45. lbs.....				
6	Acid Phosphate of Lime	221	Phosphoric Acid, 40. lbs..				
			Potassium Oxide, 40. lbs..	49,940	3341	9.8	2892
	Nitrate of Potassa.....	86	Nitric Acid, 45. lbs.....				
7	Acid Phosphate of Lime	221	Phosphoric Acid, 40. lbs..	44,500	3207	10.5	3015
8	Acid Phosphate of Lime	537	Phosphoric Acid, 97. lbs..				
	Nitrate of Potassa.....	179	Potassium Oxide, 80. lbs..	54,030	3576	11.0	3497
			Nitric Acid, 89. lbs.....				
	Sulphate of Lime.....	348	Lime, 106.5 lbs.....				
9	Animal matter.....	400	Ammonia, 67.5 lbs.....	52,940	3840	10.0	3395
10	Not fertilized			44,920	3175	12.	3357
11	Cotton Seed Meal.....	500	Ammonia, 41.5 lbs.....				
			Phosphoric Acid, 18.5 lbs.	51,710	3771	9.5	3157
			Potassium Oxide, 10. lbs..				

TABLE B.—RATTOONS.—SEVEN PLOTS.

No. of Plot.	Material used as Fertilizer.	Quantity used, in pounds.	Quantity of soluble constituents of the Fertilizer.	Weight of the Cane raised, in pounds.	No. of gallons of cane juice.	Result of Polarization apparatus.	Total amount of Sugar available, in pounds.
1	Nitrate of Potassa.....	86	Potassium Oxide, 40. lbs.. Nitric Acid, 45. lbs.....				
	Sulphate of Ammonia..	150	Ammonia, 40. lbs.....	33,380	1413	10.2	1270
	Acid Phosphate of Lime	221	Phosphoric Acid, 40. lbs..				
2	Sulphate of Lime.....	313	Lime, 102. lbs.....				
	Sulphate of Ammonia..	223	Ammonia, 55.5 lbs.....				
	Nitrate of Potassa.....	178	Potassium Oxide, 80. lbs.. Nitric Acid, 89 lbs.....	41,925	2581	9.7	2449
	Acid Phosphate of Lime	357	Phosphoric Acid, 64.5 lbs.				
3	Not fertilized.....			20,560	1350	12.8	1537
4	Animal matter.....	600	Ammonia, 50.5 lbs..... Phosphoric Acid, 49.5 lbs.	25,540	1637	12.0	1743
5	Animal matter.....	500	Ammonia, 42. lbs..... Phosphoric Acid, 62. lbs..	30,350	2141	11.2	2128
6	Animal matter	600	Ammonia, 101.5 lbs.....	30,410	2512	11.2	2497
7	Cotton Seed Meal.....	500	Ammonia, 41.5 lbs..... Phosphoric Acid, 19 lbs.. Potassium Oxide, 10. lbs..	31,660	2024	11.3	2032

N. B.—The sulphate of lime, contained in the acid phosphate of lime, has in no instance been specified; and the figures are copied as reported, except in the case of nitrate of potassa, where the amount of nitric acid has been separately stated.

II.—Mr. Thomas M. Caje's Experiments (1876)

Were carried on under nearly identical conditions as those of Mr. Thompson; the amount of cane raised upon one acre (plot) is stated in loads, equal to about 3,000 pounds each.

No. of Plot.	Material used as Fertilizer.	Quantity used, in pounds.	Quantity of soluble constituents of the Fertilizer.	Amount of Cane in loads, 3,000 lbs. each.	No. of gallons of cane juice.	Results of Polarization.	Total amount of Sugar obtainable, in pounds.
1	Superphosphate of Lime	270	Phosphoric Acid, 40. lbs..	17.	3076	13.80	3506
2	Superphosphate of Lime	270	Phosphoric Acid, 40. lbs..				
	Cotton Seed Hull Ashes	200	Potassium Oxide, 40. lbs..	20.75	3700	12.62	3848
	Sulphate of Ammonia..	160	Ammonia, 40. lbs				
3	Not fertilized.....		Phosphoric Acid, 18.37 lbs.	16.75	3007	13.83	3459
4	Cotton Seed Meal.....	500	Ammonia, 40. lbs..... Potassium Oxide, 10. lbs..	19.75	3615	13.86	4193
5	Cotton Seed Hull Ashes	200	Potassium Oxide, 40. lbs..	18.	2744	14.40	3292
6	Sulphate of Ammonia..	100	Ammonia, 25. lbs.....				
	Superphosphate of Lime	200	Phosphoric Acid, 32. lbs..	18.5	3089	13.15	3367
7	Superphosphate of Lime	400	Phosphoric Acid, 64. lbs..				
	Sulphate of Ammonia..	100	Ammonia, 25. lbs.....	21.	3331	13.20	3630
	Nitrate of Potassa.....	100	Potassium Oxide, 40. lbs.. Nitric Acid, 45. lbs.....				
8	Cotton Seed Meal.....	300	Phosphoric Acid, 42. lbs..				
	Superphosphate of Lime	200	Ammonia, 49. lbs				
	Sulphate of Ammonia..	50	Potassium Oxide, 24. lbs..	25.5	3988	13.44	4426
	Nitrate of Potassa.....	50	Nitric Acid, 25. lbs.....				
9	Blood Fertilizer.	800	Ammonia, 88. lbs.....	17.	2783	13.86	3200

Results of Experiments with Fertilizers upon Plant Cane at Calumet Plantation, Bayou Teche, La. (1877).

PLOTS ONE ACRE EACH.

No. of Plot.	Material used as Fertilizer.	Quantity used, in pounds.	Quantity of soluble constituents of the Fertilizers, in pounds.	Total cost of Fertilizers.	Weight of the Juice, in pounds.	Density, per cent. saccharometer.	Result of Polarization.	Total amount of Sugar available, in pounds.
	Nitrate Potash.....	100	Potash ..... 45.					
1	Sulphate Ammonia....	100	Ammonia. 40.8	18.67	40,766	12.	8.5	3429
	Acid Phosphate Lime..	200	Phosphoric Acid. 30.					
2	Nothing				34,710	12.5	9.5	3298
			Ammonia.....41.66					
3	Cotton Seed Meal.....	500	Phosphoric Acid. 18.83	6.90	38,353	12.	9.2	3526
			Potash 10.33					
	Acid Phosphate Lime..	537	Phosphoric Acid. 80.55					
4	Nitrate Potash.....	179	Potash 80.55	31.16	41,459	11.5	9.3	3856
	Sulphate Lime.....	358	Lime. 116.56					
			Ammonia. 28.30					
5	Tankage	600	Phosphoric Acid. 86.76					
	Cotton Seed Hull Ash..	400	Potash .....80.	12.00	40,555	12.	10.2	4136
			Ammonia. 54.48					
6	Acid Phosphate Lime..	200	Phosphoric Acid. 30.					
	Sulphate Ammonia.....	200	Ammonia.....50.	13 85	39,088	12.	9.2	3596
	Acid Phosphate Lime..	400	Phosphoric Acid. 60.					
7	Nitrate Potash.....	200	Potash .....90.	36.30	46,598	12.	8.	3727
	Sulphate Ammonia.....	200	Ammonia. 81.60					
			Phosphoric Acid. 37.50					
8	Geo. B. Forrester's Fertilizer....	500	Potash 46.25	18.80	35,507	13.	9.7	3446
			Ammonia. 16.25					
			Magnesia..... 6.50					
			Phosphoric Acid. 37.50					
9	Geo. B. Forrester's.....	500	Potash 46.25	18.70	39,793	13.	9.8	3899
	Sulphate Ammonia.....	100	Ammonia. 41.25					
			Magnesia..... 6.50					
	Dried Hog's Blood.....	250	Ammonia. 27.75					
10	Acid Phosphate Lime..	400	Phosphoric Acid. 64.	17.06	39,017	13.5	10.	3901
	Cotton Seed Hull Ash..	400	Potash .....80.					
	Cotton Seed Meal.....	500	Ammonia. 41.66					
11	Acid Phosphate Lime..	200	Phosphoric Acid. 48.83	13.28	36,566	14.	11.	4022
	Cotton Seed Hull Ash..	200	Potash 50.33					
	Dried Hog's Blood.....	200	Ammonia. 40.66					
12	Tankage	200	Phosphoric Acid. 32.10	9.00	37,991	13.	9.9	3761
	Cotton Seed Hull Ash..	300	Potash .....60.					
	Acid Phosphate Lime..	200	Phosphoric Acid. 48.83					
13	Nitrate Potash.....	100	Potash 55.33	20.23	33,797	13.5	11.	3717
	Cotton Seed Meal.....	500	Ammonia. 57.46					
	Ground Bone.....	200	Phosphoric Acid. 49.38					
14	Sulphate Ammonia.....	150	Ammonia. 61.90	20.18	41,077	13.	10.	4107
	Nitrate Potash.....	100	Potash ..... 45.					

The last season is represented as a very disastrous one to a large number of sugar planters in Louisiana. An unprecedented storm of wind and rain on the 17th and 18th of September last, entirely prostrated the cane; it did not rise again; some of it sprouted at the joints, and as the sun could not strike it at an advantage, it did in some instances not ripen enough; a very low temperature on the 1st of December, closed an exceptionally unfavorable season. Mr. Th. Caje, of Houma, La., who has carried on experiments similar to those of Mr. Thompson, suffered more than the latter, and for this reason was prevented from carrying his investigations to a satisfactory end.

XII.—On Experiments with Sugar Beet Roots.

BY PROF. C. A. GOESSMANN.

The past year has been noted for the practical turn, which a widespread interest in the promotion of the beet sugar question has taken.

Numerous and in some instances quite extensive field experiments have been carried on in many States of the Union. The results obtained have been more or less encouraging—some have failed on account of unreliable seeds; others on account of irrational modes of manuring, or deficient modes of cultivation, or too late seeding. There remains, however, scarcely any doubt, that the instructions, which may be drawn from the various trials, are more than a compensation for the disappointments experienced.

The most extensive experiments, which were made in the State of Massachusetts, were those carried on by the Hampshire Farmers' Institute Their experiments are deserving more than a passing notice, on account of being instituted in a locality, which, as far as the questions of the fitness of the soil and the extent of suitable lands are concerned, is apparently one of the best adapted for the cultivation of sugar beet roots within the State.

The seed, which served in the majority of cases, was expressly imported by me from Germany—Imperial Saxony; a variety, which on previous occasions had given very good satisfaction. In two cases, Lane's English sugar beet was planted. As the imported seeds arrived very late in the season, the planting did not take place before the 10th of June—about one month later than it ought to have been attended to in our vicinity; this circumstance may have affected the quality of the roots, when tested, as far as their full maturity is concerned.

The following tabular statement summarizes the results, which have been obtained. The tests were made under my instruction by Messrs. Bragg and Benson.

EXPERIMENTERS.	SEEDS.	SOIL.	MANURES.	Specific Gravity of Beet Juice (Brix).	Per cent. of Sugar in Beet Juice.	Per cent. of Foreign matter in Beet Juice.	Percentage of Cane Sugar in the soluble matter of the Beet Juice.
Mr. E. Chapin.....	German	Sandy Loam.	Fresh Yard Manure.	16.50°	12.50	4.00	75.08
Mr. F. Gaylord.....	German	Clayish Loam.	do.	15.50	11.05	4.45	71.30
Mr. G. Smith.....	German	Warm Alluvial.	Yard Manure or Chemicals.	12.75	9.17	3.58	71.92
Bishop Huntington..	English	do.	Fresh Hog Manure.	13.50	9.53	3.97	70.06
Mr. D. A. Horton....	English	Light Sandy Soil.	No Manure.	13.50	13.73	4.77	74.21
Mr. G. Dickenson. ..	German	Alluvial Soil.	Brighton Fertilizer.	14.50	11.15	3.35	76.90
Dr. Bonney.....	German	Heavy Soil.	Yard Manure.	12.25	8.15	4.10	66.58
Mr. S. Adams.....	German	Not stated.	Not stated.	13.50	9.90	3.60	73.33

Taking into consideration that these results have been obtained in a first attempt and under various disadvantageous circumstances, it must be conceded, that they are very encouraging. The lateness of the seeding, and the almost general application of fresh yard manure, in many instances upon lands which in previous years have been highly manured with rich nitrogenous phosphatic fertilizers, fish, etc., for the production of tobacco, without due provisions for the restitution of potash to the soil, are conditions which must make themselves felt, even in the best soils. Although the percentage of sugar is in several individual cases very satisfactory, in others it is not sufficient to render the roots fit for sugar manufacture. The foreign matter in solution is in every instance larger than desirable for manufacturing purposes, for in good sugar beet roots these substances amount to from eight (8) to twenty (20) parts for every one hundred parts of sugar. A glance at the analytical statements given above reveals the existence of serious differences.

XIII.—The Application of Polarized Light to the Examination of the Alkaloids of the Quinin Group.

BY HENRY A. MOTT, Jr., Ph.D., E.M.

It has been known for a long time, that a solution of any of the alkaloids of the quinin group affects polarized light; that is to say, possesses the power of turning the plane of polarized light either to the right or to the left; but I believe there has never been any practical application made of this fact to facilitate the examination of the alkaloids of this group, with the exception of quinin alone. Having occasion to

examine a number of samples of quinin, and having at my disposal the necessary facilities, I determined to apply this property, and see if any practical application could be made of it.

The alkaloids, which belong to the quinin group, are: Quinin, quinidin, quinicin, cinchonin, cinchonidin, and cinchonicin. The relation of these alkaloids to polarized light may be expressed as follows:

QUININ	produces	a	powerful	*left handed*	rotation.	
QUINIDIN	"	"	"	*right*	"	"
QUINICIN	"	"	feeble	"	"	"
CINCHONIN	"	"	powerful	"	"	"
CINCHONIDIN	"	"	"	*left*	"	"
CINCHONICIN	"	"	feeble	*right*	"	"

Pasteur considers that quinin and cinchonidin each contain two active groups, one of which produces strong left-handed rotation, the other producing a feeble right-handed rotation. He also regards quinidin and cinchonin as each consisting of two groups, one of which exerts a powerful right handed rotation, and the other a feeble left-handed rotation; and he supposes that in each of these bases, by the agency of heat, the more powerful group is rendered inert, whilst the weaker one remains unmodified, thus occasioning the effects observed in quinicin and cinchonicin. As these last two alkaloids do not find any use as yet in commerce, they will receive no further consideration in this paper. The other four alkaloids are met with in commerce as alkaloids, as sulphates, and, in the case of quinin and cinchonin, as muriates; and again quinin as bisulphate, other salts having but little use, and it is in the condition just mentioned, that I propose to consider them.

Before planning a process for the examination of the above-mentioned alkaloids, it becomes necessary to bear in mind the following facts:

That the rotating power of a substance is, according to Hesse,* simply the result of the variable action of its factors, viz.: the arrangement of the molecules, as regards the volume, the solvent, the temperature, the concentration, the chemical combination, the dissociation, and other things; and that "there is no real relation between the rotating power of a substance and its molecules."

With respect to the temperature, Bouchardat says: "Variation in temperature causes variation in the rotation power of quinin;" but, according to Hesse, the variation between 15° C. and 25° C. is insignificant.

Dr. John C. Draper † thoroughly investigated the effect of variation

* Annalen der Chemie, 1875.

† Am. Journ. Sci. & Arts, vol. XI, 1876.

of temperature between 25° C. and 47° C., and determined the correction for the same. He also pointed out, that the effect of diluting a solution of quinin was to diminish the power of rotation more, than the theoretical amount, and that the effect is more marked in the first dilution than in the second.

According to Bouchardat,* acids increase the rotating power of quinin solutions, ammonia restoring it to the original amount.

After carefully considering these different points, I have adopted the following method to obtain the *standard* rotation of the several alkaloids and their respective sulphates.

Each alkaloid, sulphate and muriate, in a perfectly pure condition, was thoroughly dried at 100° C., and .2 grm. (2 decigrams) accurately weighed. (As quinin is quite expensive, I determined to experiment with as small quantities as possible, and as 2 decigrams gave satisfactory results, I continued to adopt that quantity.) The weighed quantity was dissolved in a little water, acidulated with two drops of concentrated sulphuric acid, and diluted to 50 c.c., thoroughly agitated, and then examined.

The instrument used for the following observations was a Duboscq saccharometer. The tube of the instrument (20 c. c., 17½° C.) was thoroughly washed out with the solution, then filled and examined, giving the following results between the temperatures of 17½° and 24° C., which makes a very convenient field for observation :

Name.	Alkaloid.	Sulphate of the Alkaloid.	Muriate of the Alkaloid.	Bisulphate of the Alkaloid.
Quinin.....	11°.4 Left.	9° Left.	10° Left.	8° Left.
Quinidin.....	12° Right.	10° Right.	.....	.....
Cinchonin....	10° Right.	7°.5 Right.	8° Right.	.....
Cinchonidin..	7° Left.	6°.5 Left.	.....	.....

It might be thought at first, that the rotation obtained by the process just described would not represent the true rotation, as Bouchardat has shown, that acids increase the rotating power; again, that in the case of the alkaloids a certain amount of sulphate would be formed, which would tend to diminish the rotation. The object is to obtain the

* Ann. Ch. Phys. [3] IX, 213.

true rotation under the conditions stipulated. and it matters not, as long as the rotations are constant, what the rotation would be under different conditions. Alcohol has always been used to obtain the solution of the alkaloids for examination; but, as I find acidulated water answers the purpose just as well, and is considerably less expensive, I propose to use the latter. With respect to the instrument used, I selected the Duboscq saccharometer, as I have more occasion to use that instrument than any other; but any saccharometer may be used, provided the proper weight of alkaloid is taken. If the Ventzke instrument is used, it becomes necessary to weigh out .3184 gram of the alkaloid or sulphate to be examined, and the result will be precisely the same. The use of the saccharometers for the examination is very convenient, as these instruments are in more common use amongst chemists, than polariscopes; the latter though could just as well be employed, provided a table was formed for comparisons, as in the above case this could either be done by experiment or calculation.

Referring to the above table, it will be seen that any one of the alkaloids or sulphates and muriates in an elementary condition can be distinguished at once, but when a mixture of two or more of the alkaloids is examined, the task becomes more difficult and only possible under certain conditions.

Before proceeding it will be well to mention some of the substances used to adulterate these alkaloids. Water is a very common adulterant, and MM. Millon and Commaille* have shown that, when the sulphate of quinin is placed in a very moist atmosphere at 62° F., it will take up a large percentage of water—in two cases 28.77 and 32% were absorbed. Salicin is also employed, and sometimes earthy salts, also gum, starch, and fatty matters. The more expensive alkaloids, quinin and quinidin, are also adulterated with varying proportions of the other two.

The following method may be employed for the examination of the members of the quinin group, and it will be seen by the use of their property of rotation, many valuable indications and results may be obtained, which will greatly facilitate the examination.

EXAMINATION OF A SAMPLE OF UNKNOWN COMPOSITION.

A portion of the sample to be examined should be weighed, dried thoroughly at 100° C., then weighed again—the loss will equal the excess of water.

The presence of salicin in quinin may be readily detected by concentrated sulphuric acid, which turns it red.† To 1 part of the suspected

* Journ. de Pharm. Nov. 1862, p. 379.

† Am. Journ. of Pharm. XVII, 1856.

salt 6 parts of sulphuric acid may be added, and then 125 parts of water. The salicin separates, and can be obtained by filtration and weighed. It is a white bitter powder, becoming bright red, as stated, with concentrated sulphuric acid.

If the alkaloids are adulterated with starch or fatty bodies, a clear solution cannot be obtained, even in very large quantities of water.

A small portion should be tested for salts or earthy matter by ignition on a platinum foil. If a residue remains other than carbon, this should be examined in the ordinary way, first qualitatively, then quantitatively. If sulphates of lime or other sulphates are found present, they should be removed, and the mass then tested for sulphuric acid by dissolving the same in a little water, acidulated with hydrochloric acid, and then testing with baric chloride in the usual manner. If sulphuric acid is found, it is known that the substance is composed of sulphates; it becomes necessary, then, to test the substance to see if it is the sulphate or the bisulphate. Another portion should be tested for hydrochloric acid, and, if found, the substance is composed of muriates of the alkaloids.

Two decigrams of the carefully dried substance is then accurately weighed, if the Duboscq instrument is to be used, and dissolved in 50 c.c. of water, to which 2 drops of concentrated sulphuric acid has been added. The solution, after being thoroughly agitated, is tested between 17½° and 24° C. in the instrument. If the solution is found to be composed of sulphates, the 2d column is referred to; if either of the other salts, their respective columns.

Supposing the first case of the indication of the instrument is 9° to the left, it is at once known to be pure sulphate of quinin; if less than nine and more than 6°.5 left, it is known to be composed, at least partly, of quinin, and more so as it approaches the standard 9° left. If the solution indicates 10° right, then it is definitely known to be pure quinidin; if the indication is less than 10° right and more than 7°.5 right, the solution is known to contain some quinidin and more as it approaches its standard 10° right. If the indication of the instrument is 7°.5 right or 6°.5 left, the supposition is that, in the first case, it is cinchonin, and in the second cinchonidin; but nothing definite can be obtained, as regards these two indications, until further experiments are made, for they may be owing to an admixture of several or of two of the alkaloid sulphates; still the indications possess considerable value, and the rapidity with which the examination can be made is, of course, an advantage. For the further examination of the substance I have carefully prepared the following table, which shows the deportment of the several alkaloids with reagents:

Deportment of the Alkaloids with Reagents.

NAME.	Melting Point.	Solubility in Water.	Solubility in Alcohol.	Solubility in Ether.	Solubility in Chloroform.	Solubility in Dilute Acids.	Solubility in Benzole.*	Solubility in Benzole with Acid.	Solubility in Petroleum Naphtha.†	Sol. in Pet'm Naptha with Acid.	Amylic Alcohol with Acid.	Solubility in Ammonia with Water.	Solubility in fixed Alkali with Water.	Solution in Chlorine Water gives, when Ammonia is added:	Solution in Chlorine Water gives, when K_4Cfy is added, and then Ammonia.	ACTION ON POLARIZED LIGHT.
Quinia or Quinin. $C_{20}H_{24}N_2O_2$.	Crystals melt at 57° C. Solidify and remelt at 176° C.	In 460 pts., at 15° C. In 250 pts., at 100° C., containing 5 per cent. when saturated.	Soluble in all proportions of cold absolute. Soluble in 2 pts. of alcohol 95 p. cent.	In 50 pts. of absolute In 60 pts of ordinary.	In 2 pts. of chloroform. 100 pts. of chloroform dissolve 57.47 pts.	Easily soluble. Sol. in conc. acids.	Soluble.	Insoluble.	Very slightly soluble.	Insoluble.	Almost insoluble.	Slightly soluble.	Insoluble.	An emerald green color	Rose color at first, afterwards becomes red.	Alcoholic solution a = —141.38° at 25° for red ray, = —121.5° at 22.5°, and —129.56° at 16° C. For solutions in acetic or sulphuric acids, a = —287.16° at 24° C. for transition tint; —220.15° for red ray. Authorities: De Vrij & Alluard.
Quinidia or Quinidin. $C_{20}H_{24}N_2O_2$.	Melts at 160° C.	In 1500 pts of water in the cold. In 750 pts. of boiling water.	In 45 p's. of cold absolute. In 87 pts. of warm ordinary alcohol.	In 90 pts. of cold ether.	100 pts. of chloroform dissolve 25 3 pts.	Easily soluble.	Soluble.	Insoluble.	Insoluble.	Insoluble.	Almost insoluble.	Insoluble.	Insoluble.	An olive green col'r, even in solut'ns containing $\frac{1}{5000}$ th. In conc. sol. a prec. is formed.	Produces a red color, and when reagents are in certain proportions, a permanent bulky precipitate.	Solution in absolute alcohol turns the plane a = +250.75° for transition tint. Authority: Pasteur.
Cinchonia or Cinchonin. $C_{20}H_{24}N_2O$.	Melts at 257° C.	In 2500 pts of boiling water.	In 176 pts of alcohol at 15° C. In 30 pts. of boiling, 90 p. c.	In 600 pts. of ether at 17° C. In 470 pts. at 100° C.	Soluble in 40 pts. 100 pts. of chloroform dissolve 2.5 pts.	Easily soluble.	Soluble.	Insoluble, or very slightly.	Nearly insoluble.	Insoluble.	Slightly soluble.	Insoluble.	Insoluble.	White precipitate	Yellowish solution, with white precipitate.	An alcoholic solution acidulated with sulphuric acid gives a = +190.40°.
Cinchonidia or Cinchonidin. $C_{20}H_{24}N_2O$.	Melts at 175° C.	In 2580 pts at 17° C. In 1858 pts at 100° C.	In 12 pts. of alcohol, sp.gr. 0.835 at 17° C. In 3.7 pts. of boiling absolute.	In 144.5 pts. of cold ether. 100 pts. of solution contains only .70 pts	Soluble.	Easily soluble. Insol. when cold. Slightly when hot	Insoluble.	Insoluble.	Almost insoluble.	Insoluble.	Slightly soluble.	Insoluble.	Insoluble.	The solution is slightly tinted orange red.	Tint of solution, yellowish green.	A solution in absolute alcohol at 18° C. gives a = —144.61°. Authority: Pasteur.

* Benzole (of coal tar) distils at 60° to 80° C., leaving no residue. } See Prox. Org. Anal., by Prescot, p. 128.
† Petroleum naphtha " " 40° to 60° C., " " " "
The acid used with benzole, naphtha, etc., is H_2SO_4 added to acid reaction, and forming sulphates.

From this table valuable indications can be obtained, especially from the column containing the deportment of the alkaloids dissolved in chlorine water, with ammonia and with ferrocyanide of potassium and ammonia. The presence of cinchonia may be demonstrated by Liebig's method: 0.5 grams of the salt is weighed, and added to 5 grams of ether; the mixture is agitated, and 1.5 grams of concentrated ammonia added. If no cinchonia is present, two liquid layers are obtained; if it is present, a layer of this alkaloid is formed directly above the ammonia. The amount of quinin may be directly determined by decanting and evaporating the ethereal solution, and weighing the residue. Quinidin is also precipitated with cinchonin by ether. Its presence may be demonstrated by dissolving 1 gram of the sulphate in 30 grams of boiling water, and adding to the solution ammonium oxalate. Oxalate of quinidin being soluble, alone remains in solution, from which, on filtering and adding ammonia, the quinidin may be precipitated.

The above test for cinchonin has been modified by M. O. Henry,* by heating the substance first with ammonia, so as to drive off excess of alkali before adding the ether, cinchonin being slightly soluble in ammonia.

M. Rogers† has also found that 25 grms. of ether is necessary for the solution of the quinin in one gram of the sulphate, while 10 grams of ether with two per cent. of alcohol will produce the same effect.

Dr. Wm. Bird Herapath's test for the examination of the alkaloids, together or separate, becomes quite valuable after a little experience. It consists in adding carefully drop by drop to a solution of the alkaloids, in alcohol, acidulated with sulphuric or acetic acid (10 pts. alcohol and $\frac{1}{20}$th acid), an alcoholic solution of iodine, and keeping the mixture at 130° F. until perfect solution takes place; upon cooling the liquid, crystals will gradually form. In the case of quinin, the crystals are called herapathite, and are emerald-green when viewed by reflected light, but almost colorless by transmitted light, and present a curious play of colors under various circumstances of position. They polarize light, in which property they are equal, if not superior, to tourmaline. 100 parts of this herapathite, called sulphate of iodo-quinin, if dried on a water bath, represent 56.5 parts of pure quinin. With a little practice, the sulphate of iodo-quinin can be distinguished from the other salts by the different tint with reflected and transmitted light.‡

Mr. Walter Stoddard has found that, if a drop of a solution of

* Journ. de Pharm., 3e serie, XII, 102; XVI, 327; XXI, 284.

† Journ. de Pharm., Mars, 1862, p. 204.

‡ See Am. Journ. Pharm., May, 1858, p. 246; Pharm. Journ., March, 1858.

potassic sulpho-cyanide be added to a saturated neutral solution of the quinin alkaloids, crystals of sulpho-cyanide of the alkaloids form, which can be readily distinguished one from the other under the microscope.*

Mr. Palen's test for distinguishing quinin from cinchonin is also quite valuable. If a solution of polysulphuret of potassium is added to a solution of these alkaloids, the quinin will be thrown down as a red viscid mass, which hardens on cooling and assumes a resinous appearance, whereas cinchonin is separated as a white powder containing sulphur.†

If, after a thorough investigation of the substance under examination only cinchonin or cinchonidin are found, the percentage of these alkaloids may be readily calculated from the indication of the instrument, or if only two of the alkaloids are found, the percentage of each can be calculated by comparing the indication of the instrument with the standard rotation of each alkaloid as given in the table. Combining these facts with those previously stated, it will be seen that the method I have described for the examination of the alkaloids of the quinin group by their property of turning the plane of polarization, becomes quite valuable, as determinations can be made by this process, in most cases, in the space of fifteen minutes, or even less.

XIV.—On the Estimation of Precipitated or Reduced Phosphoric Acid in Superphosphates.

BY CHAS. M. STILLWELL, A. M.

Within the past few years the manufacture of superphosphate of lime has largely increased. In all first-class manufactories of this article, the composition of the materials used is known, and the manufacturer makes up his goods to suit the varying needs of his customers. It is all-important, then, that the methods of analysis used by chemists should be accurate and well fitted to the special service demanded of them. And as a difference of half a per cent. will in some cases determine the acceptance or rejection of a superphosphate, it is very important that some one method of analysis should be uniformly adopted by chemists, especially if, in certain respects, it is arbitrary in its nature.

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* Pharm. Journ., Oct., 1864, p. 155; Am. Journ. of Pharm., Jan., 1865.

† Journ. de Pharm., Mar., 1864, p. 459.

My attention was first drawn to the subject of this paper by differences between my analyses of certain superphosphates, and the results obtained by others from duplicate samples. The amount of insoluble phosphoric acid was smaller than that found by me, hence the proportion of precipitated phosphoric acid was proportionately increased. This difference could only be explained on the supposition that a different method of analysis was used. It seemed desirable, if possible, to examine the various methods in use, and, through the medium of our society, to settle upon a uniform plan which should be the standard. I therefore sent a circular to each of the following chemists, asking for such information:

W. O. Atwater, Middletown, Conn.
B. P. Blanpied, Dartmouth Agric. Col., Hanover, N. H.
C. Elton Buck, Wilmington, Del.
G. C. Caldwell, Cornell Univ., Ithaca, N. Y.
C. F. Chandler, Columbia Col., N. Y.
F. A. Genth, Univ. Pennsylvania, Phila., Pa.
C. A. Goessmann, Amherst, Mass.
S. A. Goldschmidt, School of Mines, Columbia Col., N. Y.
W. M. Habirshaw, New York.
S. W. Johnson, New Haven, Conn.
R. C. Kedzie, Agric. Col., Lansing, Mich.
W. K. Kedzie, Agric. Col., Manhattan, Kansas.
W. J. Land, Atlanta, Ga.
A. R. Ledoux, Agric. Exp. Station, Chapel Hill, N. C.
G. A. Liebig, Patapsco Guano Co., Balt., Md.
W. McMurtrie, Dept. of Agric., Washington, D. C.
A. Means, Newton Co., Oxford, Ga.
J. M. Merrick, Boston, Mass.
Chas. U. Shepard, Jr., Charleston, S. C.
S. P. Sharples, Boston, Mass.
W. Simon, College of Phar., Balt., Md.
B. Terne, Phila., Pa.
T. R. Wolf, Delaware Col., Newark, Del.

Several of these gentlemen, in their replies, express their satisfaction that this subject is to be brought before the society; and state their willingness to use whatever method seems best.

The following chemists sent answers as to the previous treatment for soluble phosphoric acid; the nature, amount, and sp. gr. of solvent used; and the time and the temperature of digestion:

——	Solvent.	Sp. gr.	No. of CC. to 1 gm.	Sol. phosph. acid previously removed?	Time of digestion in min.	Temp. of digestion. °C.
*W. O. Atwater	Am. citrate	1.09	50	Yes	30	30–40°
*F. A. Genth.....	"	1.09	50	Yes	30	30–35°
C. A. Goessmann ..	"	1.09	20	Yes	30	33–38°
*S. W. Johnson.....	"	1.09	50	Yes	30	30–40°
*J. M. Merrick	"	1.09	50	Yes	30	30–40°
S. P. Sharples	"	1.09	10	Yes	30	30–40°
†C. U. Shepard, Jr...	"	1.09	75	Yes	30	40°
C. M. Stillwell...	"	1.09	50	Yes	30	40°
	"	1.09	100	No	30	55°
G. C. Caldwell.....	"	1.09	50	Yes	30	80–90°
*S. A. Goldschmidt..	"	1.09	50	Yes	45	90°
A. R. Ledoux.....	"	1.09	50	No	90	70°
G. A. Liebig.....	"	1.09	100	Yes	60	90°
W. Simon.....	"	1.09	100	Yes	60	90°
C. E. Buck	"	1 20	50	Yes	5h.	90°
W. M. Habirshaw..	"	1.09	50	Yes	36h.	Temp. of air
‡B. Terne.....	Am. tart. alk	1.09	40	Yes	1 to 2h.	20–30°
W. J. Land.....	Am. oxalate	1 gm.	75	....	1h.	21°
T. R. Wolf.....	"	1 gm.	50	Yes	1h.	100°

Prof. Caldwell writes that he has made some trials of the ammonium tartrate method with satisfactory results.

Dr. Wolf writes that the ammonium oxalate method gives satisfactory results, if the operations are conducted in precisely the same manner in all cases, but that the results are a little too high, on account of the decomposition of the insoluble phosphate. In future he intends to adopt the ammonium citrate method.

I have found that the difference between two determinations made by the two methods used by me is rarely over two-tenths of one per cent. A small gain in time is made by not removing the soluble phosphoric acid. Sometimes I use both for the same sample, and take the average result of the insoluble found. A flat, shallow pan, covered with a zinc plate, pierced with holes for the small beakers, is used. This contains a comparatively large bulk of water, and is easily kept at any required temperature. Watch glasses on the beakers prevent all loss by evaporation.

An examination of the above table will show that the main differences in the use of the am. citrate method are in the time and tempera-

* Fres. Zeit., 1871, p. 153.

† See article "On the so-called 'Reduced' phosphate and the valuation of old Commercial Fertilizers," Amer. Chemist, vol. 3, p. 254.

‡ Fres. Zeit., 1877, p. 182.

ture of digestion. A difference of 10° or 15° in temperature will not make much difference, if the digestion is continued for half an hour, but if the quantity of solvent is increased, together with a large increase of time and temperature, the insoluble phosphate will be strongly acted upon.

The original method of Fresenius, Neubauer, and Luck is already the standard in several of the State agricultural experiment stations, and is also used by other chemists who largely analyze fertilizers. I therefore recommend that this method be made the standard one for this country, and that it be used by all the chemists of our society who are called upon to analyze this class of articles. There will probably be some slight difficulty at first in its adoption, because of the smaller amount of insoluble previously found by those who have used high temperatures. Manufacturers will not understand why the insoluble should be higher, and the precipitated phosphate lower than it has been in their superphosphates. But this difficulty would soon correct itself if all analyses are made in the same manner. It needs only concerted action on our part to place this matter of precipitated phosphoric acid on a much more satisfactory footing than it has hitherto had in this country. In brief, the method is the previous removal of the soluble phosphoric acid by cold water; the digestion of the residue in a solution of ammonium citrate of 1.09 sp. gr., using at the ratio of 50 cc. to 1 gm. superphosphate; and a digestion for 30 minutes at a temperatnre of 35° to 40° C.

A few words may perhaps be of interest as to the sampling and preparation for analysis of superphospnates. One constant source of error and differences between so-called duplicate samples is, that they are not always received in air-tight tins or bottles. A sample may be sent in a bottle to one chemist, and its duplicate sent in a newspaper or a paper box to another chemist, and it is expected that the results will check each other! When a superphosphate contains from 20 to 25 or more per cent. of moisture—as many now do—it will easily lose 3 or 4 per cent. if kept in a paper for a short time. The percentage amounts of the ingredients determined are hence proportionately increased. This whole matter of keeping samples cannot be too carefully watched. In my opinion, it is very difficult, if not impossible, to so thoroughly mix such a wet superphosphate that one or two grammes will be a fair average for analysis. Some samples, if an attempt is made to powder them, will become pasty; others ball together. The mechanical condition of others is another hindrance. If much time is taken for this purpose, the sample will inevitably lose in moisture, and so increase the results obtained. I have had samples, duplicate analyses of which by other chemists showed less moisture and more phosphoric acid and

ammonia, but when calculated on a dry basis the results were almost identical. A superphosphate with only 5 or 10 per cent. of moisture might be sampled without much error.

The following plan for the analysis of superphosphates was adopted some years ago by my late partner, Dr. Walz. With a few improvements made by myself during the last two years, it has been used with the best results. An average sample of the superphosphate obtained is quickly taken, the lumps roughly broken in a mortar, and the whole average bottled. This is done in about a minute's time, and the sample thus obtained is tested for moisture, using 10 or 15 gms., thus giving the moisture of the original sample. An average of the remainder, varying in size up to half a pound or more, according to circumstances, is taken and dried on tin in a water bath. From time to time the lumps are broken as it dries; it is perhaps sifted once or twice, and a smaller average sample taken, until the final dry sample is powdered and sifted through a sieve of 100 meshes to the inch. One-fourth of a gramme of the dry average thus obtained is a much better average of the large wet sample, than one gramme or more of the original would be. The moisture in the dry sample is always determined, since it is rarely necessary to perfectly dry the superphosphate in order to powder it. Besides, it will not do to leave anything to chance, and 2 or 3 per cent. of moisture in the dried sample might make a difference of half a per cent. sometimes in the results. The percentages of the substances obtained from the dried sample are calculated to a perfectly dry basis, and then again calculated to the wet state, using the percents of moisture in the original and dried samples. In two trials for ammonia made by me, using one-half a gramme of the dried and 4 grammes of the wet superphosphate, the difference between the two duplicates of each set was 0.06 and 0.05 per cent. Of course, if volatile ammoniacal salts are present, this plan could not be used.

This method of determining the moisture in the original sample, and again in the sample prepared for analysis, is of great use, especially in the analysis of fertilizers, since some samples of blood, meat, tankage, &c., may lose 2 or 3 per cent. of moisture while being powdered.

I was told by a manufacturer that a superphosphate made from apatite could not be dried without changing the soluble phosphate into the insoluble. In the only trial I was enabled to make, this did not prove to be the fact. The superphosphate was dried for a longer time than usual, until it was perfectly dry. The soluble phosphoric acid determined from one-fourth of a gramme of the dried, and two grammes of the wet sample, differed only 0.13 per cent., a difference which I attribute as much to the imperfect average obtained from the wet sample as to the inaccuracy of the analysis.

XV.—Proceedings.

Regular Meeting, May 2d, 1878.

Vice-President Casamajor in the chair. In the absence of the Secretary, Mr. W. Shapleigh was appointed Secretary *pro tem.* The minutes of the last meeting were read and adopted.

The following were elected:

Members—E. E. Calder, Dr. Luthy.

Associates—E. D. Weston, D. D. Williamson.

Prof. Leeds read a paper: "On the Estimation of Combined Carbon in Iron and Steel."

In the discussion, that followed, several members mentioned the difficulty they had experienced in obtaining tubes of uniform bore, for use in the construction of the apparatus mentioned by Prof. Leeds for the application of his color test. He recommended Messrs. Whitall, Tatum & Co., 46 Barclay st.

Mr. E. H. S. Bailey's paper, "On some Crystals obtained in the manufacture of Chrome Alum," was withdrawn for further research.

A paper on "Blowpipe Experiments upon Chloride, Bromide and Iodide of Silver, by M. W. Iles," was read.

Mr. P. Casamajor read a paper on "Blowpipe Implements," and exhibited a compact portable lamp with crucible stand combined; also stearine candles covered with tin foil to prevent the rapid and irregular melting when used in blowpipe analyses.

A letter from Mr. Iles was read, requesting that the title of a previous paper should read: "On the Oxidation of Xylenesulphonic Acid. By Malvern W. Iles, Ph.D., and Prof. Ira Remsen."

Also a letter from Prof. Egleston, inviting the American Chemical Society to send two representatives to join a committee consisting of members from the leading scientific societies of New York, which has been appointed to prepare a bill to make the adulteration of food and medicine a penal offense.

The Vice-President was authorized to select a committee. Prof. H. Morton and Dr. E. Waller were appointed as representatives.

Dr. Chandler presented a resolution, That the Society request the Board of Directors to have all the papers already presented and accepted by the Committee on Papers and Publication, at once published. Carried.

A motion was made, To present the thanks of the Society to the Committee on Conversazione for the satisfactory and agreeable arrangements they made for the celebration of the second anniversary of the Society. Carried.

The following were proposed:

As members—Charles Johnson, Staten Island; I. B. McIntosh, E.M., Hoboken, N. J.; Lewis S. Ware, A. O. Jenks, Jersey City.

As associates—Charles Moran, Henry Bowers, Philadelphia.

Dr. Chandler exhibited a number of chemical curiosities, including:

1st. Some of the gelatin films and lead plates used for reproducing pictures by the Woodbery type process. The gelatin films are produced by exposing sheets of gelatin sensitized by bichromate of potassa under ordinary glass negatives. By the application of warm water the unchanged and protected portions of the gelatin are removed, and the dried film thus obtained, which is a picture in relief, is forced by hydraulic pressure into a thick sheet of lead. The lead plate, which is an intaglio, is then flooded with warm gelatin solution, holding a pigment in suspension, and by placing a sheet of paper or glass upon it, and applying a gentle pressure, there is obtained a gelatin picture, which is subsequently hardened by a solution of alum. Films, lead plates, and an interesting series of pictures upon paper by this process were exhibited.

2d. Alberttypes, printed in colors by Albert, of Munich, were shown. These are obtained by taking first a negative of the blue parts of a picture, by the use of a screen of colored liquid excluding the other colors from the camera. From this negative an Alberttype plate of gelatin is produced, and with blue ink (printer's ink) the blue parts of the picture are printed upon paper in the printing press. A similar negative is produced of the red parts of the picture, and printed in red ink; and another of the yellow parts, &c., &c. There is thus produced a chromo-Alberttype, which differs from the ordinary chromo-lithograph in the fact, that the surface, from which the printing is executed, is produced by the aid of photography. Of the pictures exhibited, one was a copy of an oil painting, and the other a picture of several pieces of bright colored wall papers, which were hung before the camera.

3d. A polished section of a meteorite from the desert of Atacama, Peru.

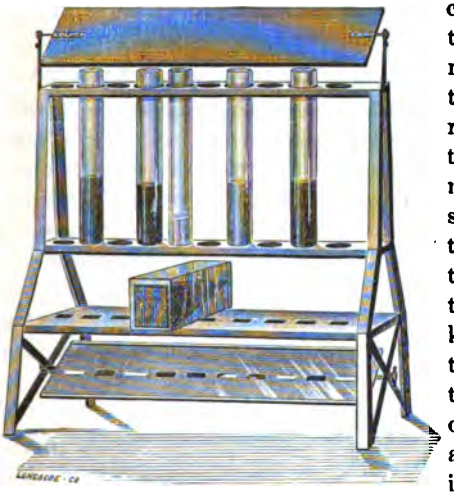
Adjourned.

W. SHAPLEIGH,
Recording Secretary pro tem.

XVI.—Alkalinity or Acidity of Potable Waters.

BY ALBERT R. LEEDS.

The color-comparator, described in the Proceedings of this Society, vol. II, may likewise be employed advantageously to make a quantitative estimation of the degree of alkalinity or acidity of potable waters. This point, in the analysis of drinking waters, does not appear to have attracted much attention, probably because these waters are, as a general rule, so nearly neutral, that they do not react alkaline or acid with the tests in general use. In the American Chemist for March, 1874, I have called attention to the great sensitiveness of an alcoholic solution of alizarine in this respect, and proposed to employ it as a means of comparing the alkalinity of drinking waters obtained from various sources. This may be done very rapidly by means of the color-comparator. One comparison tube is filled to the 100 c.c. mark with the water to be tested, and a second with water redistilled, until it has ceased to give any reaction for ammonia. 5 drops of alizarin solution are added to each, and then an antinormal soda solution run in, if, as is generally the case, the water reacts alkaline, until the liquid in both tubes has precisely the same tinge of red color. The amount of alkali added may be taken as an index of the total alkalinity communicated by the various saline bodies held in solution. Thus, on April 30th, 100 c.c. of the Passaic water, as drawn from the laboratory hydrant, acquired the same tint, when alizarin was added to it until the color no longer deepened, as 100 c.c. pure water to which the same amount of alizarine and 0.00068 grm. soda had been added. Of ordinary distilled water 100 c.c. was equivalent to 0.0003 grm. soda. This is not very far different from the amount which would be equivalent to the ammonia contained in ordinary distilled water, as determined by the Nessler reagent.



COLOR-COMPARATOR.

An attempt was made to substitute a solution of phenolphtalein for alizarine in these estimations. But there was no perceptible reddening

when phenolphtalein, in amounts considerably greater than those, which would correspond to the alizarine employed above, was added to similar samples. Phenolphtalein is far less sensitive than alizarine, and for such purposes is inapplicable. In titrating with alkali, however, it has an advantage over alizarine in the following respect: The latter changes very gradually through various shades of yellow-red to a red of different degrees of intensity. The red tint, imparted by alizarine, therefore, does not mark the endreaction very satisfactorily, and it is safer to titrate back with acid until the red tint has disappeared. With phenolphtalein the transition from a colorless solution, when a normal soda solution is added, to red is abrupt and positive. It is rather a matter of surprise to me that alizarine, as an indicator in titrations and for test paper, has not come into general use; in this laboratory it has been in constant employment for the past three years.

ESTIMATION OF COMBINED CARBON IN IRON AND STEEL WITH THE COLOR-COMPARATOR.

It is well known that when iron and steel are dissolved in nitric acid, the solution acquires a color, which is more or less brown in proportion to the amount of combined carbon present, and that a very ingenious method of carbon determinations was based by Eggertz upon this property. He obtained a standard tint by the solution of a sample containing a known amount of carbon, from which, by comparison of the depth of coloration, the percentages of carbon in other samples could be estimated.

His process has been variously modified, more especially by the substitution of a number of standard solutions, corresponding to various carbon percentages, in place of the one standard solution.*

In this case, as the solution of the metal in acid does not preserve its tint for any length of time, the standard solutions are usually made of some coloring matter like caramel. A number of test tubes are arranged in a convenient rack, and filled with solutions, beginning with a color corresponding exactly with that produced by the solution of 1 grm. of iron containing 0.02 per cent. of combined carbon in 15 c.c. of nitric acid of sp. gr. 1.20, and ending with a color corresponding to a similar iron dissolved in like manner, but containing 0.30 per cent. of combined carbon.

Instead of a series of separate tubes, varying in color by an amount corresponding to 0.02 per cent. of carbon, it is proposed to use a prism, filled with solution of caramel, or, as Britton has proposed, with a solution obtained by digesting roasted coffee in dilute spirit, and of such

* J. Blodgett Britton, Journal Franklin Institute [3], vol. LIX, p. 356.

strength as will represent every percentage between the points most frequently to be determined. 1 grm. of wrought iron or steel, in which the percentage of combined carbon has previously been determined with great accuracy, is digested with 15 c.c. dilute nitric acid at 80° for half an hour. The residue is gently heated over a lamp with 5 c.c. fresh acid, the solution added to the main portion, and filtered through a small asbestos filter. From the filtrate, a series of solutions is prepared, each reaching to the 50 c.c. mark in the comparison tubes, and each exactly half the strength as the one preceding. These tubes are then placed in the comparator, and the points on the prism, which transmit identical tints of color are carefully noted, and transferred to an application scale. 1 grm. of the sample to be analyzed is dissolved in like manner, the filtrate made up to 50 c.c. in the comparison tube, and then the prism is moved out or in, until it gives the same tint of color. The percentage, as marked on the application scale corresponding to this point, is the percentage of combined carbon in the sample under analysis.

If the percentage of carbon in the sample exceeds that indicated by the prism, a correspondingly less amount of the sample is to be brought into solution.

To illustrate the method, the following details are given:

A prism 10 in. long, with a suitable caramel solution, was provided in the manner stated, with an application scale graduated from 0.00 to 0.24 p. c. carbon. Upon a scale of this length, the intermediate percentages could readily be obtained by interpolation. The graduation was not carried higher than 0.24 per cent., because larger amounts of combined carbon gave tints of color too deep to allow of slight differences in tint being recognized by the eye with certainty. A direct comparison with a series of steels, in which the amount of total carbon (column II) had been determined by combustion, gave the following result (column I):

	COLUMN I.	COLUMN II.
Sample I	0.09	0.302
" II	0.46	0.49
" III	0.44	0.529
" IV	0.62	0.648
" V	0.72	0.801
" VI	0.76	0.841
" VII	0.80	0.867
" VIII	0.86	0.87
" IX	0.92	0.955
" X	0.96	1.005
" XI	1.04	1.058
" XII	1.12	1.079

Without attempting to explain the discrepancies between these figures, the number of correspondences was thought sufficient to warrant the publication of the method, and to give the hope that, with further trial, it might prove rapid and accurate within the required limits. My thanks are due to my assistant, Dr. Geo. A. Prochazka, for his aid in making the foregoing determinations.

STEVENS INSTITUTE OF TECHNOLOGY, May 2d, 1878.

XVII.—BLOW-PIPE EXPERIMENTS UPON CHLORIDE, BROMIDE, AND IODIDE OF SILVER.

BY MALVERN W. ILES.

THESE experiments were made with a view to find some easy and reliable method for the detection of chlorine in the presence of bromine and iodine. The methods at present employed I regard as very faulty, and the one, upon which chief reliance is placed (chloro-chromic acid method), is quite troublesome and difficult to perform, and is not at all delicate.

In the regular course of quantitative analysis, the second thing, that is done in the examination for acids, is the addition of silver nitrate; if there is a precipitate formed, insoluble in nitric acid, we conclude at once we may have chlorine, bromine, iodine, cyanogen, ferro- or ferricyanogen, one or all. Making the supposition, that all are present, everything can be detected, with a reasonable amount of care, quite readily, except chlorine, which will invariably be the element, that causes a doubt in the mind of the analyst.

Owing to the insolubility of the haloid salts of silver, and their deportment towards foreign bodies, and the action of light upon these salts, I was led to the use of pure chloride, bromide, and iodide of silver.

These salts were successively treated in a loop of platinum wire, heated with the blow-pipe, and observations made with the beads themselves, and also the coating deposited upon glass, porcelain, and various papers, when held in proximity to the beads.

Chloride of silver.

This salt fuses upon a platinum wire before the blow-pipe, or in the flame of the Bunsen burner, to a red, waxy mass; on the instant it is withdrawn from the flame it is red, soon changing yellowish red while hot; constantly lightens, and finally, when cool, it is almost colorless. When heated for some time in the oxidizing flame, metallic silver will be formed, which is occasionally thrown off in fine particles. A faint

blue color is noticed immediately around the bead, when heated before the blow-pipe. On strongly heating in the oxidizing flame, a brown vapor was noticed, which is in all probability oxide of silver.

Iodide of silver.

This fuses on a platinum wire to a dark red bead, becomes yellowish while cooling, and when perfectly cold is almost colorless. A deeper blue flame is noticed around the bead, when strongly heated, than when chloride of silver is thus treated.

There was also noticed a light blue vapor of a peculiar odor.

In this procedure not only is iodide of silver volatilized, but there is also a liberation of free iodine, which was proven by allowing the fumes to come in contact with starch paper.

Bromide of silver.

This fuses to a blood red bead, somewhat redder than chloride of silver under similar treatment. A light blue color is noticed immediately around the bead, and there is also formed an indistinct bluish vapor.

It occurred to me that it might be possible to condense, or in some way to cause the vapor of the haloid salts of silver to manifest characteristic and distinguishing actions, either upon cold surfaces or upon certain papers. I accordingly prepared a very large number of test papers, made by taking ordinary filter paper and immersing in concentrated solutions of various salts; the moistened paper was then placed on the inner surface of large, convex glass covers (about 3 to 4 in. in diam.), and resting upon any suitable support at an angle of 35°. (A common wooden filtering stand, with a wire attached to support the inclined cover, was found to be a convenient support.) The vapor from the chloride, bromide, or iodide of silver was caused to come in contact with these papers, by blowing strongly with the reducing flame upon a globule of the silver salt in a platinum loop. In no case was there sufficiently sharp and characteristic reactions to enable one to base a test for chlorine in the presence of bromine and iodine, although in a number of cases positive results were obtained. By the use of these papers the general result reached showed that chloride of silver gives a beautiful *red tint*, iodide of silver gives a distinct *yellow tint*, while the bromide of silver either gives negative results, or a faint white tint.

From these observations it can readily be seen that a large amount of chlorine can be detected in the presence of bromine and iodine; also that a small amount of chlorine can be detected in the presence of a large amount of bromine. Furthermore that an appreciable amount of iodine can be readily detected by the blow-pipe, in the presence of

chlorine and bromine. When the vapor is allowed to condense upon moistened filter paper, I found it best not to allow the point of the oxidizing flame to come in direct contact with the bead, nor should the platinum loop be held too closely to the paper.

When only chloride of silver is used, there is noticed first a faint rose tint, which gradually increases in intensity to a very dark red spot, bounded by a gradually lessening tint of red. It was noticed that the red tint produced by AgCl readily darkens in the sunlight, and gradually in diffused light; but the yellow tint produced by AgI remains permanent several days in diffused light.

A mixture of 50 p. c. each of AgCl and AgBr gave a distinct red tint. A mixture of 50 p. c. each of AgCl and AgI gave only a yellow tint—not a trace of red was visible. In a mixture containing a very large amount of bromide of silver and a small amount of iodide of silver, a distinct yellow tint was perceptible, proving the presence of iodine.

When the vapor from chloride of silver is allowed to deposit upon glass, there is seen chiefly a red spot, most intense in the center, bounded by a very faint tinge of yellow, which tint is not perceptible when one looks directly through the glass, but is distinctly seen when the glass is held at an obtuse angle. The yellow tint changes to a red upon exposure to light, and the entire spot assumes a much darker red tint.

The lemon-yellow tint produced upon glass by the vapor of iodide of silver is most intense when warm, gradually changing to a light yellow upon cooling. The yellow coating is quite permanent when exposed to light. It is difficult to say, whether the yellow coating simply covers up the red tint, or prevents entirely its formation when a mixture of chloride and bromide of silver is used.

It was noticed if the yellow tint formed by iodide of silver be held before the spectroscope, the entire violet end of the solar spectrum is cut off.

The indistinctly visible white coating formed by bromide of silver has the property of changing to a jet black, or bluish black, almost instantly when held in direct sunlight.

A large number of reagents were tried upon these coatings, but with few positive results; some of the most characteristic are as follows: Mercuric chloride, when applied in excess, causes a complete solution of the yellow coating of silver iodide; if however a dilute solution of mercuric chloride be added, there will be formed the highly characteristic bright red iodide of mercury. The coating formed by chloride and bromide of silver gives negative results with this reagent. Ammonium chloride readily dissolves the chloride of silver coating,

but does not change the iodide or bromide coating. Sodium hyposulphite dissolves the three coatings; but in the case of the chloride of silver coating, black particles of metallic silver are found in the liquid.

EXPERIMENTS WITH ZINC DUST AND THE HALOID SALTS OF SILVER.

If a bead of either chloride, bromide, or iodide of silver be treated on a platinum wire with zinc dust, and slightly heated before the blow-pipe, there will be a violent chemical action, with considerable evolution of white fumes, which are easily condensed upon cold surfaces. This coating was proven to be the haloid salts of zinc. If there be an excess of zinc, or if the bead be held too closely to the cold surface, there will be formed a black stain of metallic silver. When iodide of silver alone is treated with zinc dust as described, there is always formed a slight yellow coating of iodide of silver.

If the cold coating produced by iodide of silver be touched with a drop of mercuric chloride, an immediate and beautiful red color (HgI_2) will be seen. I find that the most minute trace of iodine can be detected in this manner, even in the presence of considerable chlorine and bromine.

Chromic anhydride, when touched to either bromide or iodide of silver beads, liberates the iodine and bromine in a free state. By blowing upon either of these beads with the oxidizing flame of the blow-pipe, there will be formed a yellowish brown coating upon porcelain.

When chloride of silver is treated in a similar manner, intensely reddish brown fumes appear, there will be a brown deposit upon porcelain, and in connection with this deposit, there will be found a liquid of a reddish tint.

A mixture of silver, mercury, and lead chlorides, when heated before the blow-pipe, and the vapor be allowed to condense upon porcelain, gives a white coating, with generally an irregular, dark boundary, owing to the formation of metallic mercury.

If this white coating be gently touched with the oxidizing flame, a distinct red color is immediately perceptible; proving, that silver can be very readily detected in the presence of mercury and lead, by means of the blow-pipe.

RESUMÉ.

1. A method has been given by which chlorine can be detected in the presence of a large amount of bromine, readily and satisfactorily.
2. Iodine can be detected in the presence of both chlorine and bromine.

3. Silver may be detected by the blow-pipe in the presence of various metallic bases as lead and mercury.
4. When chlorine, bromine, and iodine are together, the iodine must be first removed, as far as possible, in order to detect chlorine.

The method I propose for the removal is to treat the precipitate formed by nitrate of silver with a very dilute solution of ammonia, whereby all the chloride of silver will be dissolved, together with small quantities of the iodide and bromide of silver. The ammoniacal solution is evaporated to dryness in a porcelain dish, and the residue tested for chloride of silver by the method previously described.

XVIII.—Contributions to Blow-pipe Chemistry.

Second Paper.—Blow-pipe Lamp and Candle.

BY P. CASAMAJOR.

Blow-pipe Lamp.—The oil lamp most generally used in blow-pipe analysis is of a pattern first proposed by Berzelius. The body of this lamp is low and narrow, but its length is quite disproportionate to its other dimensions. This length is nearly five inches, while the other dimensions are not quite an inch each way. The foot of this lamp is formed of two cross pieces which come apart when the lamp is dismounted, the length of each piece being about seven inches. The excessive length of this lamp and of the cross pieces of its foot, were not objectionable if we consider the plan adopted by Berzelius for carrying his blow-pipe instruments when traveling.

These were packed in a surgeon's pouch, made of a piece of leather about 40 inches long and 18 inches wide, lined with another piece of the same length, and 10 inches wide. Over these two thicknesses was a third piece six inches wide, stitched in several places, so as to make from twenty-five to thirty sheaths for holding the instruments. As the widest piece of leather projected about 4½ inches on each side of the 10 inch lining, the extra width was folded over, and the edges were tied together with strings. Each sheath was made by placing the six inch leather over each instrument and stitching it down, so that every instrument fitted exactly in its sheath. This pouch, when rolled up, allowed all the instruments to be carried in safety in the smallest possible compass.

For this manner of carrying instruments they require to be flat and narrow, although they may be quite long. This accounts not only for the elongated shape of the oil lamp, but also for that of alcohol lamp, the anvil and the reagent box adopted by Berzelius.

The blow-pipe oil lamp which I present you this evening, is not adapted for being packed in a leather pouch, like the one before men-

tioned. I have endeavored to obtain the minimum of volume, combined with every advantage which is found in the lamp of Berzelius.

The lamp is cylindrical and quite flat. In the one we have here the height of the cylindrical portion is one inch, and the diameter three inches. The top is curved and provided with two openings closed with screw caps. One of the openings is for the wick, and the other is to fill the lamp without disturbing the wick.

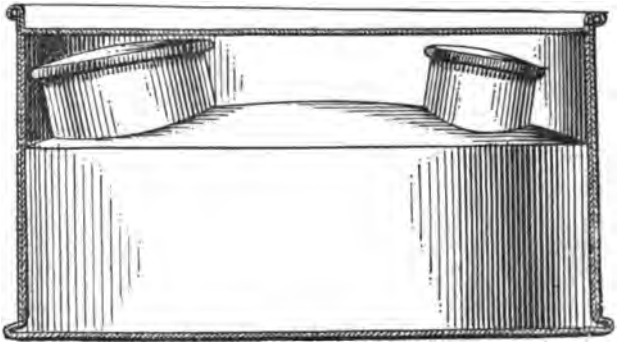


FIG. 1. FULL SIZE.

The lamp is held in a covered box, as shown in figure 1. When the lamp is to be used, it is taken out of its box, which then serves as a foot. By drawing the cover out, more or less, the lamp may be raised or lowered to suit the convenience of the operator. The lamp on its foot is shown in figure 2.

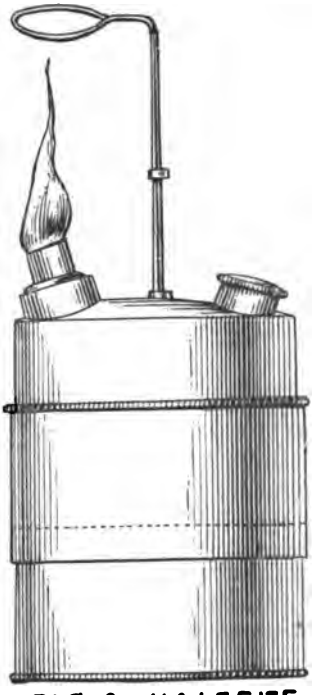


FIG. 2. HALF SIZE.

To make the lamp as low as possible when put away in its box, the wick is lowered down in the lamp, as shown in figure 3. When the lamp is to be used, the wick is pulled up again. This is done by soldering the tube that carries the wick in a cylinder surmounted by a cap. This cylinder fits loosely in the larger tubulure of the lamp, and is provided with four long slits in which enter four pins attached to this tubulure. When the wick is to be lowered it is turned around until the four slits come opposite the four pins, and the wick tube is pressed down. Besides the four slits, the cylinder attached to the wick tube has four notches into which the same pins enter when the wick tube is raised and turned

around an eighth of the circumference. Figure 3 shows the wick

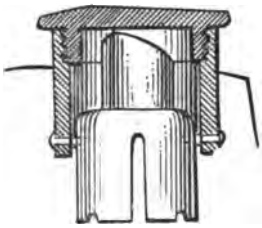


FIG. 3. FULL SIZE.

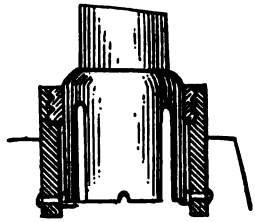


FIG. 4. FULL SIZE.

lowered down, and figure 4 shows it raised. In figure 3 may be seen one of the slits and two of the notches spoken of, and in figure 4 are two slits and one notch midway between the slits.

For the convenience of heating small dishes or crucibles over the flame, a ring is placed over it, as shown in figure 2. This ring is made of brass wire, which, after being curved round in a circle, is prolonged outwards in the direction of the diameter, and finally curved downwards at right angles. This last portion of the wire is about three-quarters of an inch long, and enters in a vertical tube *a*. The tube *a* enters in another vertical tube *b*, which, in its turn, enters another tube which goes through the lamp, and is soldered to its top and bottom. The tube *a* enters very freely in the tube *b*, and this latter tube enters with equal ease in the tube soldered to the lamp. Each one of the tubes, *a* and *b*, is provided with an appendix made of spring brass, which fits so tightly round the tube that, although it may be moved up and down, it will remain in any position in which it is placed. This appendix, in each tube, rests on the top of the larger tube below it,* so that by moving either or both up and down, the ring over the flame may be raised or lowered. When the lamp is packed in its box, the tubes *a* and *b* are placed in the space between the top of the lamp and the top of the box (see fig. 1). The ring is also placed in the same space, and its shank, which is made to enter the tube *a*, is then placed in the tube that goes through the lamp.

The application of a tube, soldered to the top and bottom of the lamp is equally feasible with the oil lamp of Berzelius. In this lamp, as now used, a tube placed at one of the ends slides up and down a vertical rod. By placing the tube in the middle of the lamp, the cross-pieces of the foot need be no longer than the lamp itself, the reduced length insuring greater stability than can now be obtained with the cross pieces seven inches long. By the use of a foot whose pieces are

* In fig. 2, the lower tube (tube *b*) has not been drawn properly. It ought to have a larger diameter than the tube *a* that enters into it..

no longer than the lamp, and vertical rods, analogous those I have described, the portability of the Berzelius lamp could be very much improved.

The box in which the lamp is packed, besides serving as an adjustable stand, answers the useful purpose of a covering to prevent the lamp from soiling things that might otherwise come in contact with it, as, with the best care and the tightest joints, it is impossible to prevent a little oil from leaking out.

The best oil to use is olive oil, which should be of the best quality, as even the best is not any too good. I have lately added to olive oil one-fifth its volume of kerosene oil (refined petroleum), which makes the oil rise more freely in the wick and prevents incrustations, without making the flame perceptibly more smoky.

Blow-pipe Candle.—The older Swedish chemists of pre-Berzelian times, to whom belongs the honor of laying the foundations of blow-pipe chemistry, Cronsted, Bergman and Gahn, used candles for fuel. Gahn used a triple candle, formed of three small candles in one candlestick, so as to obtain a more powerful flame. He also tried an oil lamp, with which he became disgusted, as it had no provision to prevent leakage of oil.*

Stearic acid candles give a flame which is, to say the least, as good as that given by the best olive oil. The material itself is less costly than good olive oil, and there is no question that, for traveling, stearic acid candles are infinitely more convenient than oil.

Candles, however, present a serious objection. The heat of the blow-pipe flame melts a candle in the part immediately under the flame more rapidly than in any other part, so that the melted material runs all down that side, and the wick gets very little of it.

I have tried several means of preventing this, but only lately have I found a practical way of overcoming the difficulty. This consists in wrapping a sheet of tin foil, about as thick as fine writing paper, round the candle. The sheet of tin foil should be of the same length as the candle, and its width should be at least one inch more than the circumference of the candle. The tin foil is put over the candle, and its two edges are brought together, so that when the tin foil is pressed tightly against the candle, there remain two thicknesses of foil about half an inch wide. These two thicknesses are folded over so as to present a projection of four thicknesses a quarter of an inch wide. This is again folded over so as to present eight thicknesses in a projection of one-eighth of an inch, which is finally flattened down on the candle.

* Berzelius.—Use of the Blow-pipe in Chemical Analysis and Mineralogical Determinations.

When a candle, dressed in tin foil in this manner, is burnt, the melted material remains in the tin foil, and no amount of blowing will make it run. If the candle is allowed to burn down, the tin foil will melt as soon as it rises high enough to come opposite the hot part of the flame, but there will always remain a cup of melted stearic acid to feed the wick.

When a candle dressed in tin foil is used, the operator can keep the tin foil at a convenient height with very little trouble. If the blow-pipe flame is directed against the envelope, the tin melts down immediately to the level of the melted stearic acid. With a pair of scissors, the tin foil can also be kept down to the proper height with very little trouble. A very ready way to keep it at the proper height, is to poke it away outwards and downwards with the butt end of the blow-pipe. It is of the greatest importance that the tin foil wrapper should be perfectly free from holes, as the stearic acid, which is kept melted at quite a depth, will all run out when it finds an outlet. If a hole is discovered in the tin foil, the readiest remedy is to place over it another sheet of the same foil about half an inch wide, and press this tightly round the candle in the same manner as the first covering.

By taking two candles and shaving off one side of each, and pressing the two flattened portions together, we may obtain a double candle which gives a very large flame. The two wicks should be about one-half inch apart. If the two candles are wrapt in tin foil, taking care that the case thus formed be prolonged under the candles, the portion of stearic acid shaved off may be melted and poured in the mold of tin foil and the two candles will be cemented into one.

XIX.—Proceedings.

Regular Meeting, Thursday, June 6th, 1878.

The meeting was called to order at 8.15 P. M., Vice-President Casamajor in the chair.

Mr. Atwater read the first paper on the determination of fats in vegetable products. For this purpose ether, in a slightly modified Johnson's apparatus, was used. The drying of the material as well as the drying and purifying of the ether are very important, since the water and alcohol (contained in commercial ether), tend to vary the results of the extraction greatly. The ether was treated with $CaCl_2$, syphoned off, this operation repeated and finally distilled, when a product of a spec. grav. as low as 0.705 at 16° was obtained. Dr. Squibb stated, that commercial ether con-

tains about 27 per cent. of an alcohol containing 15 per cent. H_2O, stronger ether 7 per cent. alcohol and traces of water, washed ether 7 to 9 per cent. watery alcohol. The specific gravity of common ether varies from 0.725 to 0.727 at 16°, after washing and treating with $CaCl_2$, so that it will stand the anhydrous copper sulphate test, 0.719 at 16°. The low gravity found by Mr. Atwater might have been due to the incorrectness of the hydrometer used.

Dr. Waldstein remarked, that according to Bayer Na must be substituted for $CaCl_2$, which is too easily decomposed.

Mr. Lipps uses equal parts of alcohol and benzolè for the extraction of fats from vegetable products; on the addition of water the benzole separates, holding the fat in solution.

Dr. Squibbs stated, that he extracts the substance crudely at first, and then the extract thus obtained, with absolute ether. It is a curious fact, that oil may be extracted from a leaf by weak alcohol, whereas the oil itself does not dissolve, unless in very strong alcohol.

Mr. P. Casamajor read the next papers on blow-pipe implements and blow-pipe reactions of alloys of lead and tin, and of iodides, bromides and chlorides.

Dr. E. F. Smith's papers: on a new monochlordiphenol and and an aniline derivative of a monochlordiphenol, and on beryllium borate, were read by title and ordered to be printed.

Prof. Leeds' paper on a new method of generating ozone, was withdrawn by the author for the evening.

On account of the lateness of the hour, the reading of the papers of E. M. Johnson and G. H. Johnson, on ferrochromium and ferromanganese, was postponed until the next meeting.

Mr. Atwater showed a very convenient bulb apparatus for N determinations; it ends in a little bulb, which serves for running in acid from a burette; also a new form of desiccator on the principle of the fruit jar, with clamp and rubber ring.

The following were elected:

As members—Chas. Johnson, J. B. McIntosh, L. S. Ware, A. O. Jenks.

As associates—Chas. Moran, Henry Bower.

On motion of Dr. Chandler, the society adjourned to the second Thursday in July.

M. ALSBERG,
Recording Secretary.

XX.—On the Quantitative Determination of Fats.

BY W. O. ATWATER, PH. D., AND G. WARNECKE.

In connection with the proximate analyses* of a somewhat extended list of vegetable and animal substances, we have taken occasion to test some of the methods, employed for the quantitative determination of fats and allied compounds, in order to learn, if practicable, the causes of the unsatisfactory results so often obtained, and the best means for improving them.

The work thus begun, speedily showed the importance of more thorough study of the action of various solvents, as ether, carbon disulphide, and light hydrocarbons, under different conditions. Of the series of investigations undertaken, but not yet fully completed, a part have to do with extraction by ether. A notice of results is given here.

Determination of Fats by Extraction with Ether.—The necessity of drying the substance, in which fats are to be determined, and of purifying the ether used, have been the main points of inquiry. The modes of drying the substance and purifying the ether, and the forms of apparatus and methods of manipulation best adapted to the purpose, have likewise been looked into to some extent.

In general, it appears, that the common method of extracting fresh or air-dry substance with ordinary ether, gives results altogether unreliable and unsatisfactory, that purifying the ether remedies the evil but partly, and that, for accurate results, it is, in general, necessary to both purify the ether and dry the substance. But with materials so prepared the results are very satisfactory, and proper apparatus and manipulation make the process one of unusual rapidity and ease.

The common methods of fat extraction with ether involve:

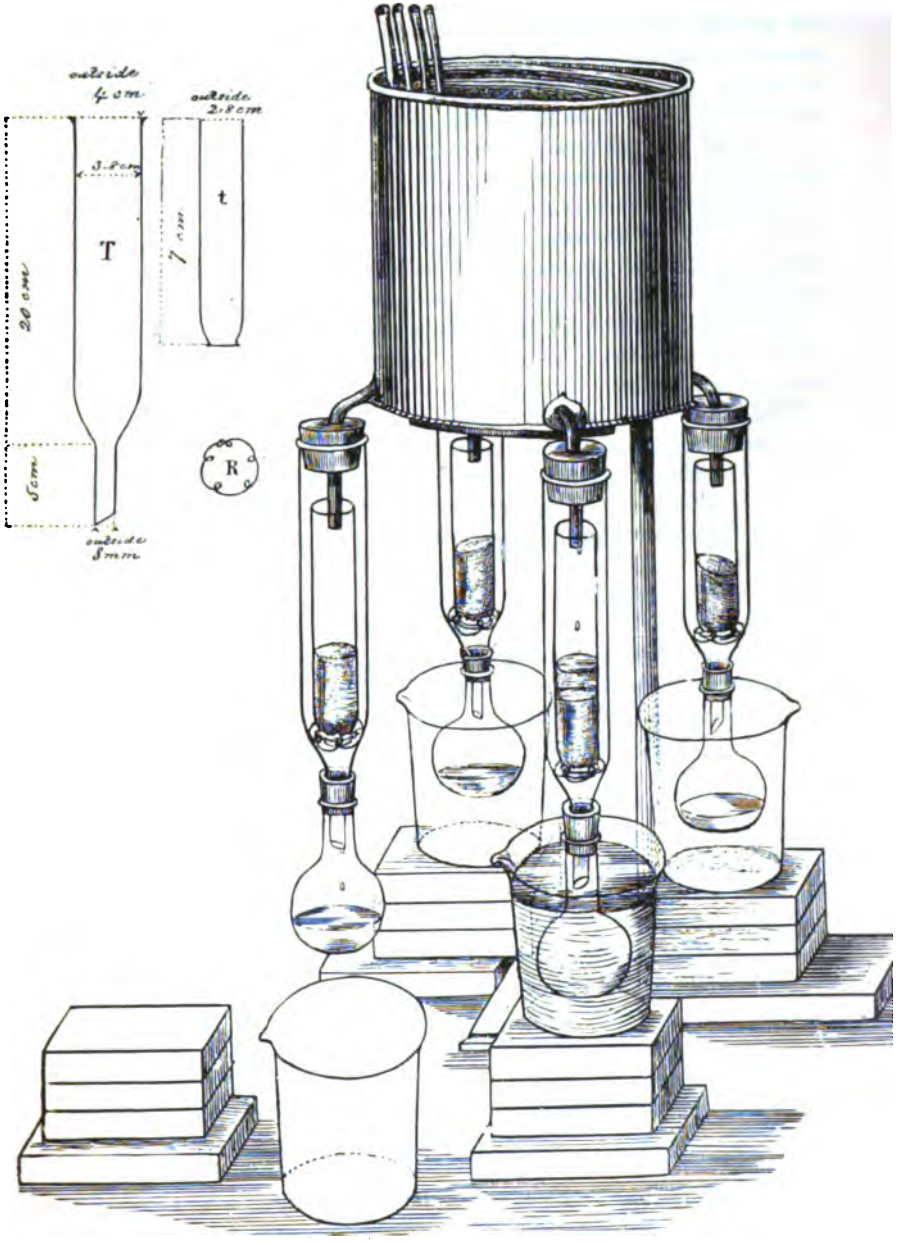
I. Digestion in the cold; either in a flask or in an apparatus (*e. g.*, those of Wagner and Kühn) especially devised to hold the ether for some time in contact with the substance, and then allow it to filter into another receptacle.

II. Digestion in warm ether (*e. g.*, Wolff, Simon).

III. Percolation by warm ether. This is usually effected by evaporating the ether, condensing and causing it to pass through the substance. Various forms of apparatus have been devised for this purpose, such as those of Pepin, Payen, von Bibra, Cloez, Gerhardt & Chancel, Storch, Stohmann, Simon, Gerber, Zulkowski, Maly, Tollens, Johnson and Schulze.

Apparatus.—The apparatus, which we have employed is represented in the figure. It combines features of several of those named, but contains nothing new except some modifications and details. To effect

* Undertaken as a branch of the work of the Conn. Agricultural Experiment Station.


outside
4 cm
outside
2.8 cm
3.8 cm
T
t
7 cm
20 cm
5 cm
R
outside
8 mm

the passage and percolation of the ether we use the apparatus described by Johnson (*Am. Jour. Sci.*, XIII, 1877, p. 196). The ether in the flask is boiled, the vapor passes up through the space between the tubes T and *t*, into the condenser, whence it drops into *t*, passes through the substance and falls freighted with fat into the flask, and repeats the round until its work of extraction is done.

We find it convenient to have the extraction tubes *t* and T rather large. For *t*, 7 cm., length by 2.8 diameter, and for T, 25 cm. length, by 3.8 cm. internal diameter are, according to our experience, good dimensions. For substances, whose lightness and low content of fat require considerable bulk for the determination, a tube *t* of these dimensions is none too large, and the size of the apparatus is no inconvenience at any time.

The inner tube *t* is conveniently sustained in T by a ring of wire, R, for which either platinum, or, with care to keep clean, copper may be used. The lower, somewhat narrowed and flanged end of *t* is closed by a piece of filter paper as recommended by Tollens, preferably the German "coffee filter paper," covered with muslin and bound by platinum wire. A filter once fixed serves for a large number of determinations.

The condenser in the figure consists of a vessel of zinc inclosing four worms of block tin pipe. The latter are of 6 mm. bore, and 1.6 meter long. They condense the ether perfectly in water of ordinary room temperature, except in summer, when the addition of ice from time to time is necessary. We find this in summer more effectual, and at all times more convenient, than a constant current of water. Instead of the zinc cooler, we have also used a bottle with the bottom broken off, the tubes being held by a perforated rubber stopper. Where only two determinations are to be made at a time, the two worms are easily fixed in an ordinary green glass bottle. This form of condenser is cheap, compact, convenient, durable and decidedly better, than Liebig's, for this work.

For the flask, 60–75 c.c. is a convenient size. It is needless to say, that filter and the corks used to connect the flask with the tube T, and the latter with the worm, should be well extracted with ether.

Process—Manipulation.—The ether is best boiled by hot water in a beaker (see figure), the water being renewed, when cool, from a supply kept hot and conveniently at hand. It is easy to regulate the evaporation of the ether so as to keep a constant current trickling through the substance. The end of the worm should be cut off square and project into the inner tube. The drops of ether are thus scattered over the surface of the substance and the formation of channels is prevented. It is easy and much better to regulate the current so as to keep the substance saturated with ether, and a layer of the latter above it. The tempera-

ture of the ether is held at near its boiling point by the surrounding current of vapor, bubbles of the vapor rise through the substance and keep it loose, the ether percolates rapidly through it and the extraction is quick and complete. When a few drops of the ether leave no perceptible residue on a watch glass, the operation is done. One hour or less generally suffices for the extraction. The ether may then be forced into the condenser and caught in another flask and preserved. The quantity of ether thus consumed is extremely small. The flask, with the fat, is warmed until the ether is all driven off and weighed with a similar flask as counterpoise. Fats, that alter on exposure to warm air, should be dried in hydrogen, as will be stated further on. With the apparatus and process described, from six to eight determinations can easily be made per day.

Quantities of Materials to be Used.—Enough material should be used to furnish from 0.07 grm. to 0.5 grm. fat. Of such substances as straw and some grades of flour, 7–10 grms. should be taken; of ordinary hay and grains 4–5 grms., and of materials like oil-cake and fish scrap 1–3 grms. will suffice. Of ether, 15–30 c.c., according to the bulk of the substance, are sufficient.

Ether.—We have used the kinds sold in the drug stores, as "commercial ether" and "stronger ether." The first has a specific gravity of about 0.750, and is said to contain 25 per cent. of 88 per cent. alcohol and some "heavy oil of wine." We have noticed no indications of sulphurous acid in the samples we have used, the reaction being uniformly neutral. The "stronger ether" is considerably purer. These have been purified by digesting for 24–72 hours with calcium chloride, drawing off the upper layer of partially purified ether, digesting again as before and distilling. We find the "stronger ether" the more economical for the purpose.

Specific gravity determinations of the products thus obtained, were made with an ordinary hygrometer, the scale of which had been approximately corrected by tests with distilled water and with absolute alcohol and ether, whose specific gravities had been determined by weighing in a pyknometer. They gave, in five cases, 0.719 at 13°, 0.719 at 18°, 0.716 at 20°, 0.716 at 22°, and 0.709 at 24°. These figures either agree with or vary by .001–.003 from those given (*e. g. Heppe Vademecum des Practischen Chemikers*, 337) for absolute ether. Ether, thus prepared, though doubtless less pure, than it would be if purified with sodium, is near enough to absolute ether to serve the purpose, and is called absolute ether in the following pages.

Use of Absolute vs. Commercial Ether, and Water-free vs. Air-dry Substance in Fat Determinations.—The directions for fat extraction with ether, as given in works on analytical chemistry generally, recommend

to treat the "substance" with "ether" simply, and say nothing about either drying the substance or purifying the ether. See, for instance, *Wolff, Chemische Untersuchung landwirthschaftlich wichtiger Stoffe, 3te Aufl., S.* 174.

On the other hand, we occasionally find a statement, that one or both precautions have been taken. For instance, Tollens mentions the use of pure ether for fodder materials;* G. Kühn,† Christenn,‡ and Lehmann,§ use water free substance in milk analysis; and Lehmann,‖ von Gohren,¶ Kühn,** Johnson, Atwater,†† and König,‡‡ use water free substance and absolute ether in determinations of fat in fodder materials and milk.

The Determinations have been made by three methods, using:

First, Water-free substance and absolute ether.

Second, Air-dry substance and absolute ether.

Third, Air-dry substance and commercial ether.

The results are given in the following table:

By "fats" is to be understood the "ether-extract," which, in addition to the true fats, tri-glycerides, contains more or less of other compounds soluble in ether, as wax, chlorophyll, cholesterin, lecithin, etc.; and, where air-dry substance and commercial ether are used, still other substances, whose character is less certain.

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* Jour. f. Landw. XXII, 1874, S. 254.

† Landw. Vs. St. VIII, S. 197.

‡ Landw. Vs. St. XX, S. 439.

§ Annal. d. Chem. 189, S. 358.

‖ Landw. Vs. St. III, S 193.

¶ Landw. Vs. St. V, S. 9.

** Jour. f. Landw. XXII. S. 188.

†† Am Jour. Sci. XLVIII, 1869, p. 352.

‡‡ Landw. Vs. St. XIII, 241.

TABLE I.

DETERMINATIONS OF FATS, ETHER-EXTRACT.

(Nos. III–VIII were milling products from a mixture of I and II. Nos. XI and XII were the coarsely ground and unbolted grains. Nos. 10–203 were samples of fish refuse used as fertilizers. The percentages of fats are reckoned on water-free substance in all except Nos. 10–203, in which they are reckoned on air-dry substance). For analytical details, see Table III, at end of article.

Number.	MATERIALS.	Moisture, per cent.	Percentages of Fats Obtained.								
			First Method. Water-free substance. Absolute ether.			*Second Method.* Air-dry substance. Absolute ether.			*Third Method.* Air-dry substance. Commercial ether.		
			Per cent.	Per cent.	Average.	Per cent.	Per cent.	Average.	Per cent.	Per cent.	Average.
I.	Wheat, Michigan White Winter	12.75	1.45	1.43	**1.44**	1.47	1.52	**1.50**	2.05 2.47 2.19 2.41	1.88 2.33 2.78 2.40	**2.31**
II.	Wheat, Missouri Red Fall	13.52	1.73	1.66	**1.70**	1.81	1.87	**1.84**	1.85 2.01	2.15 2.00	**2.00**
III.	Wheat Shorts (Bran)	11.31	2.57	2.63	**2.60**	2.49	2.61	**2.55**	4.09 3.45	3.56 3.84	**3.74**
IV.	No. 2 Middlings	12.27	3.03	3.06	**3.05**	3.00	3.03	**3.02**	4.35 4.46	4.71	**4.51**
V.	No. 1 Middlings	11.32	2.33	2.33	**2.33**	2.52	2.55	**2.54**	2.24	2.77	**2.53**
VI.	Purified Middlings	12.35	1.42	1.41	**1.42**	1.44	1.51	**1.43**	1.77 1.58	1.78	**1.69**
VII.	New Process Flour	13.50	1.31	1.28	**1.30**	1.52	1.57	**1.55**	2.01	2.04	**2.03**
VIII.	No. 1 Flour	11.98	0.84	0.83	**0.84**	1.15	1.14	**1.15**	1.51 1.44	1.35	**1.43**
IX.	No. 2 Flour	12.46	0.61	0.67	**0.64**	1.17	1.33	**1.25**	1.22 1.15	1.28	**1.22**
X.	No. 3 Flour	10.80	1.15	1.17	**1.16**	1.19	1.27	**1.23**	1.56 1.37	1.43	**1.44**
XI.	Rice Feed	15.11	1.92	1.87	**1.90**	1.98	1.88	**1.93**	3.15	2.33	**2.74**
XII.	Barley Feed	9.85	3.62	3.56	**3.59**	4.31	3.89	**4.10**	5.53	4.50	**5.02**
XIII.	Timothy Hay, just before blossom	3.45*	1.90	1.90	**1.90**	2.14	2.00	**2.07**	2.98	1.92	**2.45**
XIV.	Timothy Hay, early in blossom	2.78*	1.36	1.38	**1 37**	2.19	1.33	**1.76**	2.49	2.39	**2.44**
XV.	Timothy Hay, in full blossom	5.48*	1.57	1.61	**1.59**	2.26	2.20	**2.23**	4.63	5.12	**4.88**
XVI.	Timothy Hay, ripe	3.88*	1.90	1.88	**1.89**	2.17	1.81	**1.99**	2.02	2.65	**2.34**
XVII.	Clover Hay, just before blossom	3.22*	1.66	1.72	**1.69**	2.09	2.37	**2.23**	2.98	2 87	**2.93**
XVIII.	Clover Hay, early in blossom	6.18*	2.09	2.14	**2.12**	3.16	3.24	**3.20**	3.46	3.08	**3.27**
XIX.	Clover Hay, in full blossom	1.82*	1.67	1.70	**1.69**	1.91	1.91	**1.91**	3.01	2.75	**2.88**
XX.	Clover Hay, ripe	3.60*	1.76	1.68	**1.72**	1 79	1.79	**1.79**	2.76	2.49	**2.63**
XXI.	Fodder Corn	2.55*	1.43	1.53	**1.48**	1.41	1.41	**1.41**	3.31 3.09	3.43	**3.28**
XXII.	Fodder Corn	3.29*	1.34	1.26	**1.30**	1.51	1.44	**1.48**	2.86 3.02	3.04	**2.97**
XXIII.	Fodder Corn	4.78*	1.00	1.01	**1.01**	1.01	1.01	**1.01**	2.58 2.57	2.54	**2.56**
XXIV.	Hungarian Grass, early in blossom	7.23	2.03	2.04	**2.04**	2.45	2.46	**2.46**	2.77	2.76	**2.77**
XXV.	Hungarian Grass, in full blossom	7.20	1.82	1.83	**1.83**	2.17	2.11	**2.14**	2.19	2.32	**2.26**
XXVI.	Hungarian Grass, nearly ripe	7.78	1.72	1.67	**1.70**	1.85	2.06	**1.96**	2.18	2.15	**2.17**
XXVII.	Linseed Cake	9.18	13.12	13.24	**13.18**	13.36	13.47	**13.42**	13.65	13.66	**13.66**
XXXV.	Linseed Powder	7.54	37.01	36 90	**36.96**	37.17	37.02	**37.10**	37.24	37.16	**37.20**
XL.	Turnip Seed	5.86	42.04	42.04	**42.04**	42.97	43.84	**43.41**	42.86	42.72	**42.79**
	Milk	....	4 31	4.31	**4 31**	....	....	....	4 28	4.25	**4 27**
10.	"Dry Ground Fish," "Fish Guano"	13.74	6.71	6.71	**6.71**	11.53	11.47	**11.50**	12 24	12.53	**12 39**
24.	" " " "		6.33	6.33	**6.36**	10.23	10 56	**10.40**	10.77	14.00	**12.39**
100.	" " " "	14.64	7.68	7.68	**7.68**	10 95	11.40	**11.18**	11.80	12.37	**12.09**
172.	" " " "	13.45	6.65	6.62	**6.64**	8.60	8 59	**8.60**	7.76	9.61	**8.69**
185.	" " " "	6.34	7.31	7.35	**7.34**	7.51	7.60	**7.56**	9.56	9.54	**9.55**
203.	"Crude Fish Scrap," dried in laboratory	8.21	8.99	8.95	**8.97**	11.51	11.66	**11.59**	11.81	11.82	**11.82**
179.	"Dry Fish Scrap"	11.04	3.92	3.93	**3.93**	4.53	4.40	**4.47**	4.56	4.27	**4.42**
189.	" "	11.00	8.32	8.29	**8.31**	10.98	12.86	**11.90**	12.27	12.68	**12.48**
181.	"Half-dry Fish Scrap"	25 10	12.00	12.00	**12.00**	13.00	14.70	**13.85**	16.22	17.92	**17.07**
197.	" "	56.83	15.59	15.65	**15.62**	17.79	17.13	**17.46**	18.74	18.98	**18.86**

* Had been partially dried before grinding for analysis.

Among the most noteworthy facts revealed by the table, are the following:

1. *By the First Method.* Where the ether was purified and the substance dried, the duplicates agree uniformly. In the forty duplicate analyses, eighty determinations, the differences between duplicates exceeded one-tenth of one per cent. in only two cases (No. XXVII, 0.12, and No. XXXV, 0.11), and were in the majority from 0.04 per cent. to nothing.

II. *By the Second Method.* With air-dry substance and absolute ether, the duplicates generally agreed very well. Occasionally wide differences occurred. The averages were in nearly every case larger than by the first method. The absolute ether takes more material from the air-dry, than from the water-free substance, and this excess of extract is neither the same in duplicate determinations of the sample, nor constant for materials of like composition, nor proportional to the amount of water in the substance. As will be seen farther on, the determinations, whose duplicates agreed best, were frequently far from correct. In three-fourths of the cases, duplicates were less than 0.09 per cent. apart. In the forty cases there were four disagreements between 0.50 per cent. and 1.00 per cent., and two over 1.00 per cent. Some examples are given below:

NO.	MATERIAL.	MOISTURE P. CT.	EXTRACT P. CT.	DIFFERENCE.
XII.	Barley Feed	9.85	4.31–3.89	0.42 per cent.
XIV.	Timothy Hay	2.73	2.19–1.33	0.86 "
XL.	Turnip Seed	5 86	42.97–43.84	0.87 "
100.	Dry Ground Fish.	14.64	10.95–11.40	0.45 "
189.	Dry Fish Scrap	11.00	12.86–10.93	1.93 "
131.	Half-dry Fish Scrap.	25.10	13.00–14.70	1.70 "
197.	" "	56.83	17.79–17.13	0.66 "

We have said that the determinations by this method also gave larger amounts of extract in nearly every case, than were obtained by the first method, where the substance was dried. This is illustrated in table II, in which the average amount of extract from each substance by the first method is taken at 100, and the amounts by the other methods are reckoned in proportion.

TABLE II.

Number.	MATERIALS.	Moisture in Substance, per cent.	Extract Obtained.		
			First Method.	*Second Method.*	*Third Method.*
I.	Wheat, Michigan White Winter	12.75	100.	104.	160.
II.	Wheat, Missouri Red Fall	13.52	100.	108.	118.
III.	Wheat Shorts (Bran)	11.31	100.	98.	144.
IV.	No. 2, Middlings	12.27	100.	99.	148.
V.	No. 1, Middlings	11.32	100.	109.	109.
VI.	Purified Middlings	12.35	100.	101.	119.
VII.	New Process Flour	13.50	100.	119.	156.
VIII.	No. 1 Flour	11.98	100.	137.	170.
IX.	No. 2 Flour	12.46	100.	195.	191.
X.	No. 3 Flour	10.30	100.	106.	124.
XI.	Rice Feed	15.11	100.	102.	144.
XII.	Barley Feed	9.85	100.	114.	140.
XIII.	Timothy Hay, just before blossom	3.45	100.	109.	128.
XIV.	" early in blossom	2.73	100.	128.	178.
XV.	" in full blossom	5.48	100.	140.	306.
XVI.	" ripe	3.88	100.	105.	123.
XVII.	Clover Hay, just before blossom	3.22	100.	132.	173.
XVIII.	" early in blossom	6.18	100.	151.	154.
XIX.	" in full blossom	1.82	100.	118.	170.
XX.	" ripe	3.60	100.	104.	153.
XXI.	Fodder Corn	2.55	100.	94.	219.
XXII.	"	3.29	100.	114	228.
XXIII.	"	4.73	100.	100.	253.
XXIV.	Hungarian Grass, early in blossom	7.72	100.	121.	136.
XXV.	" in full blossom	7.20	100.	117.	123.
XXVI.	" nearly ripe	7.73	100.	115.	128.
XXVII.	Linseed Cake	9.13	100.	102.	104.
XXXV.	Linseed Powder	7.54	100.	100.	101.
—	Milk	—	100.	—	99.
XL.	Turnip Seed	5.86	100.	104.	102.
10.	Dry Ground Fish, "Fish Guano."	18.74	100.	170.	185.
24.	" " "	—	100.	164.	195.
100.	" " "	14.64	100.	146.	170.
172.	" " "	13.45	100.	130.	131.
185.	" " "	6.34	100.	103.	130.
203.	"Crude Fish Scrap," dried in labor'y.	8.21	100.	130.	133.
179.	"Dry Fish Scrap."	11.04	100.	114.	112.
189.	" "	11.00	100.	144.	151.
131.	"Half-dry Fish Scrap."	25.10	100.	115.	142.
197.	" "	56.83	100.	112.	121.

By reference to table I, it will be seen that in the three cases, Nos. III, IV and XXI, when the second method gave less than the first, the difference in the averages by the two methods, as reckoned upon substance, were 0.05 per cent., 0.03 per cent. and 0.07 per cent. respectively, or less than one-tenth of one per cent., which is not wide for the

limits of error. Counting the results, that come within one-tenth of one per cent., reckoned on substance, as agreeing, the results by the two methods agree in six cases. In all the rest the second method yields more than the first, the excess being, in eighteen cases, from 11 per cent. to 50 per cent., and in four from 51 per cent. to 95 per cent. of the amount obtained by the first method. This plus obtained, when the water is left in the substance, is found in every sample of fish, does not appear to any considerable extent in the oil seeds, and, in the samples of hay, grain and flour, is sometimes very large and sometimes zero. That it is not proportional to the amount of moisture is evident from the following figures:

No.	Material.	Moisture.	Extract, 1st Method.	Extract, 2d Method.
VII.	New Process Flour	13.50	100.	119.
VIII.	No. 1 Flour	11.98	100.	137.
IX.	No. 2 Flour	12.46	100.	195.
X.	No. 3 Flour	10.30	100.	106.
XV.	Timothy Hay	5.48	100.	140.
XVII.	Clover Hay	3.22	100.	132.
10.	Dry Ground Fish	18.74	100.	170.
100.	" "	14.64	100.	146.
189.	Dry Fish Scrap	11.00	100.	144.
197.	Half-dry Fish Scrap	56.83	100.	112.

Fats and all the compounds, that have any right to be classed with them, are readily soluble in pure ether. Ether and water together dissolve other substances. With pure ether and dry substances duplicates always agree, and with remarkable closeness. But when the water is left in the substance, duplicates sometimes agree and sometimes vary, while the extract is generally increased, sometimes from 50 to nearly 100 per cent. It is very true, that by heating, drying, oxidation, etc., the solubility of animal and vegetable substances is changed. But such agencies could hardly explain such results as these. Nos. XIII–XXVI had been heated and partly dried before grinding for analysis, and yet they show the same excess of extract as the others. It is difficult to see, what this plus of extract in the undried substance can be due to, unless it be the water.

For such materials as oil-seeds and milk, the drying may not be so necessary. But the above data plainly justify the conclusion, that, in general:

In the quantitative estimation of fats by ether, unless the substance is dried, more or less of compounds, that do not belong with the fats will be extracted with them.

III. *By the Third Method*, where air-dry substance and commercial ether were used, the duplicates sometimes agree, but more frequently disagree. The variations are utterly irregular and often very wide. The averages almost always exceed those by the second method, and

are always larger than by the first, being, in some cases, twice and even three times as great with undried substance and impure ether as where both were free from water, and the ether free from alcohol also.

Below are examples from table I, of agreement and variation of duplicates. They are cited, as in the previous case, to illustrate what wide variations are introduced by wrong methods, and how utterly fallacious a test for the correctness of an analysis is the agreement of duplicates when the process is not certainly correct.

No.	Materials.	Moisture.	Extract.
I.	Wheat.....	12.75	1.83–2.05–2.19–2.33–2.40–2.41–2.47–2.78
III.	Wheat Shorts	11.31	3.45–3.56–3.84–4.09
VII.	New Process Flour.	13.50	2.01-2.04
VIII.	No. 1 Flour.....	11.98	1.35–1.44–1.51
IX.	No. 2 Flour.....	12.46	1.15–1.22–1.28
XII.	Barley Feed.....	9.85	4.50-5.53
XIII.	Timothy Hay.....	3.45	1.92–2.98
XIV.	"	2.73	2.39–2.49
XXV.	Linseed Powder....	7.54	37.16–37.24
100.	Dry Ground Fish...	14.64	11.80–12.37
189.	Dry Fish Scrap....	11.00	12.27–12.68
131.	Half-dry Fish Scrap.	25.10	16.22–17.92
197.	" "	56.83	18.74–18.98

The amounts of extract obtained by this method, as compared with the other two, are illustrated by the following figures from table II:

No.	Moisture, per cent.	Extract obtained, 1st Method.	2d Method.	3d Method.
I.	Wheat..... 12.75	100	104	160
VII.	New Process Flour.. 13.30	100	119	156
VIII.	No. 1 Flour..... 11.98	100	137	170
XV.	Timothy Hay..... 5.48	100	140	306
XVI.	" 3.88	100	105	123
XVII.	Clover Hay..... 3.22	100	132	173
XXII.	Fodder Corn..... 3.29	100	114	228
XXVII.	Linseed Cake..... 9.13	100	102	104
XXXV.	Linseed Powder..... 7.54	100	100	101
	Milk..... —	100	—	99
10.	Dry Ground Fish... 18.74	100	170	185
100.	" " ...14.64	100	146	170
189.	Dry Fish Scrap..... 11.00	100	144	151
197.	Half-dry Fish Scrap. 56.83	100	112	121

By the second method, with water in the substance, there was an excess of extract over that obtained where no water was present. And just as might be expected, by the third method, where, in addition to the water in the substance, there were also water and alcohol in the ether, the extract is still greater.

Since, as we have said, both the true fats and the other compounds which, occurring with them, have, on account of similarity of composi-

tion, physiological function or technical use, a right to be classed with them, are freely soluble in ether, the excess dissolved by the water and alcohol has no right to be classed as fat, or even as "ether extract." The amount these foreign matters obtained from oil-seeds, oil-cake, and milk, was inappreciable; in the hay, grain and milling products, it was sometimes small, and sometimes as large or even twice as large as the amount of fats proper. In the fish scrap, likewise, it was such as to make the results of the analyses from 10 to 100 per cent. higher than they should be. We are therefore warranted in concluding that, in general:

In the quantitative estimation of fats with ether, not only should the substance be dried, but the ether must be pure. The omission of either of these precautions brings other compounds into the extract, and renders the results inaccurate and unreliable.

The Method of Drying the Substance may be important for the determination of both moisture and fat. The following case is in point. The dryings were made at 100° in air and in hydrogen:

		Moisture.	Fat.
No. XXXV.	Linseed powder, dried in air.....	5.48 p. c.	20 79 p. c.
" " "	hydrogen.	7.54 "	37.00 "

The larger amounts of water and fat obtained, when dried in hydrogen, are easily explained on the assumption that the oxidation of the oil in drying in air counterbalanced part of the loss of water, and rendered a portion of the oil insoluble in ether. The correctness of this assumption, and the substances whose drying in hydrogen is necessary, are now being investigated.

The Fineness of Grinding necessary in preparing substances for extraction with ether has been tested in some of the coarser samples. All of the materials, except the milling products, Nos. III–X and No. XXV, were finely ground in a mill made for this purpose.* No. III was a very coarse wheat bran. Its particles, tested by one of the seives devised by Prof. Nobbe, of Tharand, for sifting seeds, were from 1.5 to 3 mm. in diameter. Nos. IV, XI, XII, XXXV, and XL were finer, and had no particles larger than 1.5 mm. diameter.

Samples as below were ground in purified sand, and parallel determinations made with these and other portions as they came from the mill. Results as below:

		Not ground with sand.	Ground with sand.
No. III.	Wheat Shorts (Bran)....	2.60 p. c.	2.78 p. c.
" IV.	No. 2 Middlings	3.05 "	3.04 "
" XI.	Rice Feed	1.90 "	1.92 "
" XII.	Barley Feed.....	3.59 "	3.58 "
" XXXV.	Linseed Powder	37.00 "	36.96 "
" XL.	Turnip Seed Powder....	42.04 "	42.04 "

* By Mechanicus Apel, in Göttingen, Germany.

The only sample in which the extract was increased by grinding with sand was the coarse wheat bran, whose particles were from 1.5 to 3 mm. diameter. The others, in which some of the particles reached, but none exceeded 1.5 mm. diameter, were completely extracted. It would appear, then, that if the sample is ground so that none of its particles exceed 1.5 mm., further grinding is not necessary.

In Conclusion. The figures cited above show, that with water-free substance and absolute ether less extract is obtained than is ordinarily given in analyses of like materials. But, using air-dry substance and ordinary ether—as is, to say the least, often practiced in this country and in Europe—we do not find it difficult to obtain results comparable with any that can be adduced.

The main results of this investigation may be briefly stated as follows:

1. *For correct estimations of fats by ether, it is, in general, necessary to use dry substance and pure ether. Where either of these precautions is neglected, substances are brought into the ether-extract, which do not belong there, and the results are rendered inaccurate and unreliable.*

2. *The ether may be purified sufficiently by treatment with calcium chloride and distillation at 36° centigrade. Substances that alter in composition or solubility on heating in air should be dried out of access of air.*

3. *The substance should be ground fine enough to leave no particles more than 1.5 mm. diameter.*

4. *Sufficient substance should be taken to furnish 0.07—0.1 grm. or more of extract.*

5. *From 15 c.c. to 30 c.c. of ether suffice for one determination.*

6. *One hour or less is generally sufficient for the extraction.*

7. *With apparatus, as above described, arranged for eight extractions at once, it is easy to make eight determinations per day.*

ANALYTICAL DETAILS.

A. Moisture.

Number.	Substance taken, air-dry.	Yielded substance, water-free.	Water-free substance, per cent.	Number.	Substance taken, air-dry.	Yielded substance, water-free.	Water-free substance, per cent.	Number.	Substance taken, air-dry.	Yielded substance, water-free.	Water-free substance, per cent.
I....	2.638	2.271	87.25	XII....	3.048	2.748	90.15	XXIII....	3.287	3.084	95.27
II....	3.181	2.751	86.48	XIII....	2.959	2.857	96.55	XXIV....	3.657	3.393	92.78
III....	2.671	2.369	88.69	XIV	4.027	3.917	97.27	XXV....	4.279	3.971	92.80
IV....	2.542	2.230	87.73	XV	3.122	2.951	94.52	XXVI....	3.587	3.310	92.27
V....	2.881	2.555	88.68	XVI....	2.732	2.626	96.12	XXVII....	13.410*	12.198	90.82
VI....	4.404	3.860	87.65	XVII....	3.446	3.335	96.78		9.880*	8.519	90.92
VII....	3.526	3.050	86 50	XVIII....	4.127	3.872	93.82	XXXV....	4.880*	4.511	92.44
VIII....	3.941	3.469	88.02	XIX....	4.452	4.371	98.18		6.214*	5 746	92.47
IX....	3.516	3.078	87.54	XX....	3.697	3.564	96.40	XXXV....	18.220	17.222	94.52
X	4.489	3.982	89.70	XXI....	3.727	3.632	97.45	XL...	19.434	18.295	94.14
XI ...	2.045	1.736	84.89	XXII....	2.401	2.322	96.71				

* Dried in hydrogen.

B. Fat Determinations.

Number.	First Method.			Second Method.				Third Method.			
	Water-free substance taken.	Fats obtained.	Fats, per cent.	Air-dry substance taken.	Water-free substance calculated.	Fats obtained.	Fats, per cent.	Air-dry substance taken.	Water-free substance calculated.	Fats obtained.	Fats, per cent.
I....	7.511	0.109	1.45	7.270	6.343	0.093	1.47	2.010	1.754	0 036	2.05
	8.888	0.127	1.43	11.022	9.617	0.146	1.52	3.877	3.383	0.062	1.83
	....	....	....	....	....	....	....	1.625	1.418	0.035	2.47
	....	....	....	....	....	....	....	1.672	1.459	0.034	2.33
	....	....	....	....	...	....	....	1.728	1.508	0.033	2.19
	....	....	....	....	....	....	....	1.113	0.971	0.027	2.78
	....	....	....	....	....	....	....	1.931	1.615	0.039	2.41
	....	....	....	....	....	....	....	1.670	1.457	0.035	2.40
II....	8.026	0 139	1.73	6.766	5.851	0.106	1.81	2.124	1.837	0.034	1.85
	7.279	0.121	1.66	7.772	6.721	0.126	1.87	2.100	1.816	0.039	2.15
	....	....	....	....	....	....	....	1.667	1.442	0.029	2.01
	....	....	....	....	....	....	....	1.558	1.347	0.027	2.00
III....	4.587	0.118	2.57	5.379	4.811	0.119	2.49	2.371	2.103	0.086	4.09
	6.494	0.171	2.63	6.882	6.104	0.159	2.61	1.170	1.038	0.037	3.56
	....	....	....	....	....	....	....	1.111	0.985	0.034	3.45
	....	....	....	....	....	....	....	1.351	1.198	0.046	3.84
IV....	5.274	0.160	3.03	6.695	5.375	0.176	3.00	1.915	1.680	0.073	4.35
	7.345	0.225	3.06	4.919	4.315	0.131	3.03	1.258	1.104	0.052	4.71
	....	....	....	....	....	....	....	2.170	1.904	0.085	4.46
V....	5.274	0.123	2.33	6.404	5.679	0.143	2.52	1.158	1.027	0.023	2.24
	6.126	0.143	2.33	7.873	6.982	0.178	2.55	1.388	1.227	0.034	2.77
VI....	11.801	0.167	1.42	10.031	8.792	0.118	1.34	2.128	1.865	0.033	1.77
	10.743	0.152	1.41	11.302	9.906	0.150	1.51	2.774	2.431	0.042	1.73
	....	....	....	....	....	....	....	2.093	1.835	0.029	1.58
VII....	8.411	0.110	1.31	7.837	6.779	0.103	1.52	1.954	1.690	0.034	2.01
	7.726	0.099	1.28	10.076	8.716	0.137	1.57	2.044	1.768	0.036	2.04
VIII....	9.953	0.084	0.84	7.986	7.029	0.081	1.15	1.128	0.993	0.015	1.51
	8.305	0.069	0.83	8.802	7.802	0.089	1.14	1.854	1.632	0.022	1.35
	....	....	....	....	....	....	....	2.294	2.019	0.029	1.44
IX....	9.861	0.060	0.61	8.394	7.348	0.086	1.17	1.954	1.719	0.021	1.22
	6.397	0.043	0.67	8.478	7.421	0.099	1.33	1.967	1.722	0.022	1.28
	....	....	....	....	....	....	....	1.787	1.564	0.018	1.15
X....	9.287	0.109	1.15	9.890	8.871	0.106	1.19	1 427	1.280	0.020	1.56
	7.252	0.085	1.17	7.085	6.355	0.081	1.27	1.636	1.467	0.021	1.43
	....	....	....	....	....	....	....	0.980	0.879	0.012	1.37
XI....	5.983	0.115	1.92	5.288	4.489	0.089	1.98	5.460	4.635	0.146	3.15
	6.786	0.127	1.87	8.062	6.844	0.129	1.88	6.679	5.670	0.132	2.33
XII....	5.157	0.187	3.62	6.076	5.478	0.236	4.31	4.756	4.288	0.237	5.53
	5.756	0.205	3.56	8.178	7.372	0.287	3.89	6.232	5.618	0.253	4.50
XIII....	3.317	0.063	1.90	3.970	3.833	0.082	2.14	3.993	3.855	0.115	2.98
	3.680	0.070	1.90	2.595	2.505	0.050	2.00	2.698	2.605	0.050	1.92
XIV....	3.080	0.042	1.36	3.896	3.790	0.082	2.19	4.255	4.139	0.103	2.49
	2.973	0.041	1.38	3.318	3 227	0.043	1.33	4.941	4.806	0.113	2.39
XV....	3.428	0.054	1.57	4.353	4.114	0.093	2.26	3.767	3.561	0.156	4.63
	3.286	0.053	1.61	5.725	5.411	0.119	2.20	4.050	3.828	0.196	5.12
XVI....	2.786	0.053	1.90	4.122	3.962	0.086	2.17	3.508	3.373	0 068	2.02
	3.664	0.064	1.88	4.602	4.423	0.080	1.81	4.120	3.910	0.105	2.65
XVII....	5.254	0 087	1.66	7.991	7.784	0.162	2.09	3.951	3.824	0.114	2.98
	4.360	0.075	1.72	5.412	5.238	0.124	2.37	4.483	4.290	0.123	2.87

B. Fat Determinations—*continued.*

Number.	*First Method.*			*Second Method.*				*Third Method.*			
	Water-free substance taken.	Fats obtained.	Fat, per cent.	Air-dry substance taken.	Water-free substance calculated.	Fats obtained.	Fat, per cent.	Air-dry substance taken.	Water-free substance calculated.	Fats obtained.	Fat, per cent.
XVIII....	5.443	0.114	2.09	5.152	4.834	0.153	3.16	3 818	3.582	0.124	3.46
	4.491	0.096	2.14	4.538	4.258	0.138	3.24	4.223	3.962	0 122	3.08
XIX....	3.892	0.065	1.67	5.378	5.280	0.101	1.91	6.326	6.211	0.187	3.01
	4.167	0.071	1.70	4.857	4.769	0.091	1.91	4.192	4.119	0.113	2.75
XX....	2.958	0.052	1.76	5.497	5.299	0.095	1.79	2.966	2.859	0.079	2.76
	3.988	0.067	1.68	4.982	4.803	0.086	1.79	4.048	3.902	0.097	2.49
XXI....	3.493	0.051	1.46	4.153	4.047	0.057	1.41	0.745	0.726	0.024	3.31
	3.064	0.047	1.53	3.431	3.344	0.047	1.41	0.781	0.761	0.026	3.43
	....	....	....	....	....	....	....	0.697	0.679	0.021	3.09
XXII....	2.163	0.029	1.34	3.699	3.577	0.055	1.51	0.904	0.874	0.025	2.86
	3.168	0.040	1.26	2.355	2.278	0.033	1.44	0.645	0.624	0.019	3.04
	....	....	....	....	....	....	....	0.513	0.496	0.015	3.02
XXIII....	3.609	0.036	1.00	3.436	3.273	0.033	1.01	0.652	0.621	0.016	2.58
	4.073	0.041	1.01	3.834	3.653	0.037	1.01	0.537	0.512	0.013	2.54
	....	....	....	....	....	....	....	0.449	0.428	0.011	2.57
XXIV....	7.690	0.156	2.03	4.529	4 202	0.103	2.45	4.950	4.593	0.127	2.77
	6.579	0.134	2.04	3.168	4.795	0.118	2.46	3 986	3.698	0.102	2.76
XXV....	3.563	0.065	1.82	4.762	4.419	0.096	2.17	5.765	5.350	0.117	2.19
	4.704	0.086	1.83	6.217	5.679	0.120	2.11	3.992	3.705	0.086	2 32
XXVI ...	3.721	0.064	1.72	4.084	3.722	0.069	1.85	4.583	4.228	0.092	2.18
	4.606	0.078	1.67	4.058	3.744	0.077	2.06	2.829	2.610	0.056	2.15
XXVII....	10.212	1.340	13.12	12.150	11.030	1.473	13.36	6.873	6.245	0.853	13.65
	8.521	1.128	13.24	8.659	7.868	1.060	13.47	7.541	6.853	0.936	13.66
XXXV....	4.504	1.670	37.08	7.327	6.775	2.518	37.17	10.249	9.476	3.529	37.24
	5.734	2.117	36.92	13.336	12.330	3.644	37.02	8.345	7.716	2.867	37.16
Milk*.....	25.710	1.107	4.31	....	....	....	....	25.710	....	1.100	4.28
	25.710	1.109	4.31	....	....	....	....	25.710	.	1.092	4.25
XL....	8.698	3.657	42.04	10.824	10.190	4.379	42.97	5.653	5.322	2.281	42.86
	9.562	4.020	42.04	6.081	5.725	2.510	43.84	6.641	6.252	2.671	42.72
10.....	8.560	0.574	6.71	4.363	....	0.503	11.53	6.430	....	0.787	12.42
	6.224	0.428	6.71	4.323	....	0.496	11.47	8.985	....	1.126	12.53
24.....	7.430	0.470	6.33	3.869	....	0.396	10.23	5.656	....	0.609	10.77
	8.275	0.528	6.38	4.640	....	0.490	10.56	5.178	....	0.725	14.00
100.....	6.979	0.536	7.68	4.557	....	0.499	10.95	2.610	....	0.308	11.80
	6.387	0.491	7.68	5.098	....	0.581	11.40	2.821	....	0.349	12.37
131.....	2.190	0.263	12.00	3.593	....	0.567	13.00	5.080	....	0.824	16.22
	4.349	0.522	12.00	2.798	....	0.422	14.70	3.694	....	0.602	17.92
172.....	6.519	0.434	6.65	4.816	....	0.415	8.60	5.866	....	0 455	7.76
	5.455	0.360	6.62	3.921	....	0.337	8.59	4.588	....	0.431	9.61
179.....	4.205	0.165	3.92	3.725	....	0.169	4.53	5.646	....	0.241	4.56
	4.817	0.185	3.93	5.134	....	0.226	4.40	4.932	....	0.225	4.27
185.....	5.060	0.372	7.31	5.662	....	0.425	7.51	4.569	....	0.437	9.56
	4.772	0.349	7.35	6.158	....	0.478	7.60	4.422	....	0.422	9.54
189.....	4.806	0.400	8.32	4.940	....	0.54	10.93	4.507	....	0.553	12.27
	3.402	0.282	8.29	3.646	....	0.467	12.86	2.879	....	0.365	12.68
197.....	4.097	0.641	15 65	5.441	....	0.975	17.79	5.293	...	0.992	18.74
	5.985	0.933	15.59	6.613	....	1.030	17.13	5.679	....	1.078	18.98
203.....	3.128	0.280	8.95	4.144	....	0.477	11.51	3.970	....	0.469	11.81
	4.908	1.026	8.99	4.628	....	0.540	11.66	4.281	....	0.506	11.82

* The weights of milk taken refer, in each case, to fresh milk 25 c.c.

GROUND WITH SAND.

	First Method.		
Number.	Water-free substance taken.	Fats obtained.	Fats, percent.
III....	5.656	0.160	2.83
	6.727	0.184	2.73
IV....	5.961	0.181	3.04
	5.036	0.153	3.04
XI....	6.508	0.127	1.95
	5.012	0.094	1.88
XII....	7.015	0.247	3.52
	5.208	0.189	3.63
XXXV....	9.058	3.352	37.01
	7.307	2.696	36.90
XL....	6.014	2.530	42.07
	4.901	2.059	42.01

XXI.—UPON THE PRESENCE OF NITRIC ACID IN HEALTHY URINE, WITH A METHOD FOR ITS ACCURATE DETERMINATION.

BY ALBERT R. LEEDS, PH.D.

(Read at the February Meeting.)

IN the process of some experiments upon the relative amounts of oxidized and non-oxidized compounds in potable waters, it became of much importance to determine the nature of this relation in the case of urine, which is one of the organic impurities sometimes present. It had been shown, that, in the case of the Passaic water, the amount of nitric acid present was ten times that of the free and albuminoid ammonia. A similar relation, probably, exists between the oxidized and non oxidized nitrogenous compounds in many other natural waters.

The question arises, what becomes of the nitrates used for alimentation, after their absorption in the human system? In their passage through the system, do the nitrates undergo reduction, and, if not assimilated, are they voided as non-oxidized nitrogenous compounds, or do they reappear to some extent in the urine?

It is stated by Dr. William Allen Miller (Elements of Chemistry, Part III, p. 815), that "the quantity of sulphuric acid in the urine is

mainly influenced by the proportion of azotized food taken; this acid, indeed, appears to be derived principally from the sulphur contained in the albuminoid compounds assimilated from the food. When a mixed diet was used, Lehmann found the amount of sulphuric acid excreted daily to amount to 108 grains; with an animal diet it rose as high as 165 grains, and when a purely vegetable diet was consumed, the quantity of sulphuric acid excreted in the twenty-four hours fell to 90 grains." The production of sulphuric acid is here ascribed to the oxidation of the sulphur in the food, no account whatever being taken of the sulphates present as such in the waters drank. In fact, in any case, the amount of sulphuric acid derived from this source would be but a small portion of the total amount usually present in urine.

According to the analysis of Dr. Miller, urine contains in 1000 parts 43 parts of solid matters, of which 1.7 parts are sulphuric acid. No mention is made of the presence of nitric acid in any of the analyses given in books, to which I have had access. But, from the point of view taken above, I felt unwilling to concede the absence of nitric acid in the urine, until I had submitted this question to a method of inquiry a recent discovery had put into my hands. (See "Contributions from the Laboratory of the Stevens Institute of Technology," 1878.)

To the contents of a retort, previously freed from all traces of pre-existent ammonia, by distilling in it pure water until no further traces of ammonia were obtained, 1.023 gramme of fresh healthy urine was added, and the distillation continued. The distillates were collected in portions of 100 c.c. and 50 c.c., and the amount of ammonia in each distillate separately determined. The results were as follows:

(1)....100 c.c.=0.24 mgrm.	(9)....100 c.c.=0.08 mgrm.
(2).... 50 c.c.=0.12 "	(10)....100 c.c.=0.09 "
(3)....100 c.c.=0.16 "	(11)....100 c.c.=0.08 "
(4).... 50 c.c.=0.105 "	(12)....100 c.c.=0.085 "
(5).... 50 c.c.=0.12 "	(13)....100 c.c.=0.08 "
(6)....100 c.c.=0.17 "	(14)....100 c.c.=0.09 "
(7)....100 c.c.=0.13 "	(15)....100 c.c.=0.085 "
(8)....100 c.c.=0.09 "	

Total amount evolved in 15 distillations was 1.725 mgrm. While these results were of value by showing that on boiling alone urine underwent a very slow decomposition with the evolution of slowly diminishing amounts of ammonia, yet the progress being tedious, it was decided to accelerate the decomposition by the addition of a gramme of sodium carbonate.

(1)....	100 c.c.	=0.075 mgrm.	(21–30).	1000 c.c.	=1.30 mgrm.
(2)....	"	=0.24 "	(31–39).	900 c.c.	=1.17 "
(3–10).	800 c.c.	=1.44 "	(40–48).	900 c.c.	=0.765 "
(11)....	100 c.c.	=0.185 "	(49)....	100 c.c.	=0.085 "
(12)....	"	=0.175 "	(50)....	"	=0.07 "
(13)....	"	=0.18 "	(51)....	"	=0.05 "
(14)....	"	=0.16 "	(52)....	"	=0.04 "
(15)....	"	=0.24 "	(53)....	"	=0.03 "
(16)....	"	=0.17 "	(54)....	"	=0.045 "
(17)....	"	=0.155 "	(55)....	"	=0.045 "
(18)....	"	=0.145 "	(56)....	"	=0.0425 "
(19)....	"	=0.175 "			
(20)....	"	=0.17 "			7.1525 mgrm.

Although it would have been more satisfactory to have continued the distillations with sodium carbonate, until there was no further evolution of ammonia, yet at the end of 56 distillations the process was interrupted, and 0.87 per cent. was assumed to represent the percentage of ammonia given off by urine on boiling alone and with sodium carbonate very nearly.

The distillation was then recommenced, after the addition of 50 c.c. of a solution of potash and potassium permanganate.

(1)....	100 c.c.	=0.32 mgrm.	(13)....	100 c.c.	=0.06 mgrm.
(2)....	"	=0.11 "	(14)....	"	=0.06 "
(3)....	"	=0.07 "	(15)....	"	=0.05 "
(4)....	"	=0.05 "	(16)....	"	=0.06 "
(5)....	"	=0.055 "	(17)....	"	=0.035 "
(6)....	"	=0.035 "	(18)....	"	=0.02 "
(7)....	"	=0.04 "	(19)....	"	=0.02 "
(8)....	"	=0.135 "	(20)....	"	=0.02 "
(9)....	"	=0.04 "	(21)....	"	=0.02 "
(10)....	"	=0.035 "	(22)....	"	=0.005 "
(11)....	"	=0.035 "			
(12)....	"	=0.035 "			1.31 mgrm.

In other words, 0.13 per cent. of ammonia was obtained by the decomposition of the nitrogenous compounds in urine, which had resisted the action of boiling, alone and with sodium carbonate.

Six grammes of zinc were digested with a slightly warmed solution of neutral cupric sulphate, and after careful washing, the residue, together with the freshly precipitated copper, introduced into the retort. The distillation was then continued with the following results:

(1)....	100 c.c.	=0.10	mgrm.
(2)....	"	=0.03	"
(3)....	"	=0.025	"
(4)....	"	=0.0125	"
(5)....	"	=0.04	"
(6)....	"	=0.16	"
(7)....	"	=0.07	"
(8)....	"	=0.12	
(9)....	"	=0.0575	"
(10)....	100 c.c.	=0.0325	mgrm.
(11)....	"	=0.06	"
(12)....	"	=0.065	"
(13)....	"	=0.0225	"
(14)....	"	=0.0005	"
(15)....	"	=0.0000	"
(16)....	"	=0.0000	"
		0.7955	mgrm.

But by previous determinations it had been found that 50 c.c. of the permanganate solution yielded, when treated with excess of zinc and copper, 0.29 mgrm. ammonia, which, subtracted from the preceding result, gave for the ammonia due to the reduction of the nitrates in the urine 0.5055 mgrm., corresponding to 1.887 mgrm. nitric acid, or 0.18 per cent.

I find in the Proceedings of the Royal Society for 1854–'55 (vol. VII), a memoir by Dr. Bence Jones "On the Oxidation of Ammonia in the Human Body," in which he states that in the last edition of Prof. Lehmann's Animal Chemistry, vol. II, p. 363, a very decided opinion is expressed against a conclusion, to which he had arrived in consequence of some experiments, published in the Philosophical Transactions for 1851.

I have not been able to refer to the original article by Dr. Jones, but find it stated, that he took as the starting point in his research his observation to the effect, that the urine after administration of doses of carbonate of ammonia does not manifest an alkaline reaction, while, when doses of potassium tartrate are administered, it does. Hence he inferred, the ammonial salts undergo oxidation in the system. This inference he claims to have substantiated by the application of the indigo and protosulphate of iron tests, and also that of starch, potassium iodide and dilute hydrochloric acid. It is well known that a mixture of the three last-named substances give a dark-blue color, when added to a solution containing a very slight trace of nitrous acid. In Dr. Bence Jones' experiments, the urine, after administration of ammonial salts, was distilled with sulphuric acid, and the distillates treated with the above test. A blue color was developed, which Dr. Jones attributed to the presence of nitrous acid. The ground of Prof. Lehmann's objection was, that sulphurous acid was probably formed as well as nitrous acid, and that sulphurous acid also will decompose hydriodic acid. In reply, Dr. Bence Jones shows that sulphurous acid does not decompose hydriodic acid, and that Prof. Lehmann probably fell into error by employing potassium iodide containing iodate. Moreover, that, so far from sul-

phurous acid having power to liberate iodine, it hinders its liberation. The formation of the blue color is prevented, when to a mixture of potassium iodide, starch and dilute hydrochloric acid containing nitrous acid, sulphurous acid is added, or, if sulphurous acid is added after the blue color is formed, it causes the color to disappear.

It may be considered, then, that Dr. Jones has disposed of the objection urged against his original experiments, and has established the presence of nitric acid in the urine, after the administration of ammonial salts. But the statement, that I have myself heretofore made, that nitric acid is present as a normal constituent, is itself open to the objection, that the method of analysis employed may be fallacious; in other words, that the nitric acid may be formed during the course of the analysis by action of the oxidizing agent, potassium permanganate, employed. It is desirable to settle this point definitely by suitable experiments. In the meantime it may be urged:

1st. That numerous nitrogenous compounds have already been subjected to this trial, and do not appear to have undergone oxidation.*

2d. Artificial urine, subjected to the action of a reducing couple of copper and zinc, did not yield ammonia in quantity sufficient to make it probable, that the ammonia so obtained, was derived from any other source than traces of ammonium salts accidentally present.†

3d. If potassium permanganate oxidizes the nitrogenous compounds to the form of nitric acid, then Wanlyn's and Chapman's method for the determination of albuminoid ammonia is fallacious to a corresponding extent. In any experiment, it could not be determined what fraction of the albuminoid bodies had been driven off in the form of "albuminoid ammonia," and what fraction was left behind in the form of nitric acid. But it will be seen by referring to article entitled, "New Method for the Estimation of Nitrates in Potable Waters," this journal, that the amount of nitric acid, as determined in potable water, after oxidation by potassium permanganate, was nearly identical with that, obtained, when determined in the ordinary method, and consequently in this case previous oxidation, if any such occurred, was too slight to affect the values found.

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* Ber. der Deutsch. Chem. Gesell., Vol. X, No. 17, S. Hoogewerff and H. A. Van Dorp.

† T. E. Thorpe, Jour. Chem. Soc., Vol. XI, 1873, p. 541.

XXII.—Contributions to Blow-pipe Chemistry.

THIRD PAPER.—MISCELLANEOUS NOTES.

BY P. CASAMAJOR.

I. The Shortest Pocket Blow-pipe.

Over two years ago, I published in the *Chemical News* (February 4th, 1876), and in the *American Chemist* (December, 1875), a description of a blow-pipe, which, when packed for the pocket, has a length of $4\frac{1}{2}$ inches, and, when adjusted for use, gives a length of 8 inches from the mouth-piece to the tip of the jet. This relation of $4\frac{1}{2}$ to 8 was a trifle less than that of any pocket blow-pipe that had previously been proposed.

In the above description, as published in the *Chemical News*, occurs the following: "If the stem of the blow-pipe is made in two pieces, while the jet is made with a double curve, the length, when put up for the pocket, can be reduced to $3\frac{1}{4}$ inches, which gives the still smaller ratio of $3\frac{1}{4}$ to 8, which, I believe, has never before been attained. I have one of these dimensions, whose stem is formed of two conical portions with circular sections. When packed for carrying, one cone fits within the other, and the curved jet fits within the inner cone."

As neither at the time of publishing the above, nor since then, have the figure or a detailed description of this blow-pipe been given, I propose to give both now, as I believe that this blow-pipe still enjoys the distinction of being, when packed for the pocket, the shortest ever made. In figure 1, it may be seen in this condition, and, in figure 2, it is shown as arranged for use.

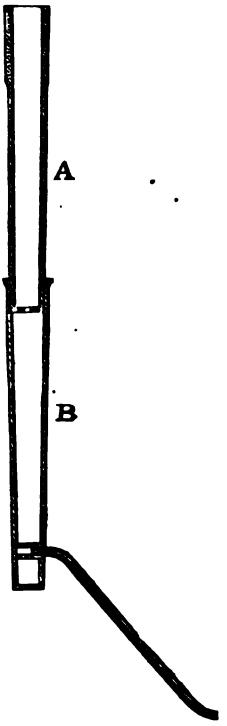
In this figure, we may see that the stem is formed of two conical tubes A and B, of about the same length. The small end of A enters into the large end of B. The larger end of A is left open, while its smaller end is closed with a plate having a hole in its center, to allow the passage of the air into B. The conical tube B is also open at its larger end, but closed by a plate at its smaller end. About half an inch from the smaller end is an opening in the tube B, made to receive a small piece of pipe, which is soldered to edges of the opening, and to a place inside of the tube B, diametrically opposite to the opening. This short piece of pipe, which serves as a socket to receive the jet, is provided with a hole, to allow the air to escape from the tube B into the jet.

A blow-pipe of this kind is very easily made by taking two ordinary jeweler's blow-pipes, which cost about 15 cents a piece, and filing off

the curved portion. There remains two straight conical tubes, which are placed one within the other. We may then cut from the outside tube a piece about 3 inches long, from which we make the tube A. At the smaller end is soldered a perforated plate. From the inside tube we make the pipe B, by closing its smaller end with a plate, and by putting a ring around its larger end. This ring answers the purpose of stiffening this end, and keeping its shape true, and it also serves to take hold of when the tube B is to be drawn out of the tube A (see figure 1). The perforated plate at the smaller end of A is also designed to keep this end from deformation. It also serves as a diaphragm with a small perforation to divide A from B, which allows the stem to be divided so as to leave a lower chamber, which some think is an advantage in the case of the blow-pipe of Gahn, commonly ascribed to Berzelius or Plattner.

Fig. 1. (full size.)

Fig. 2. (Scale ½.)



It may be noticed in the figures, that the larger end of A is made thicker than the rest of this tube. This extra thickness represents a silver tube soldered over the brass tube in the part that enters in the mouth.

The jet is made from a piece of brass tubing. Before curving it, it should be filled with rosin, to prevent it from collapsing. This jet should be made to fit very accurately in a larger piece of tubing, which is afterwards soldered in the tube B, to serve as a socket for the jet, as shown in figure 2. To prevent the jet from dropping out of the inner tube, this is closed with a cap, the edge of which is shown in figure 1.

II. Charcoal Borers.

In his excellent work, *On the Use of the Blow-pipe in Chemical Analysis and Mineralogical Determinations*, Berzelius gives a charcoal borer, which is remarkable for its extreme simplicity. It consists in a conical tube of tin plate, open at both ends, these ends being sharpened with a file, so as to present two circular edges. By using either the

larger or smaller end of the cone, we may bore holes of two different sizes in charcoal. The diameter of the larger end is about half an inch, and that of the smaller about quarter of an inch.

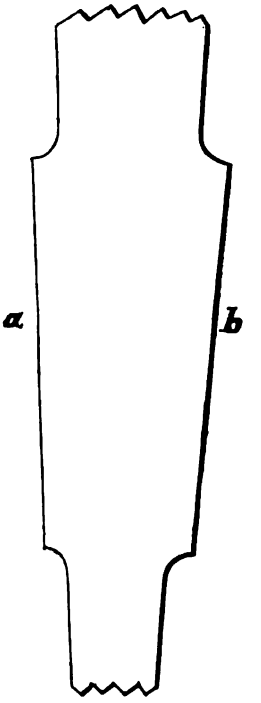
This borer is not generally known, those of Plattner being the only instruments of the kind in general use. These have the advantage of making a hole more quickly, and they never leave a core, which, in the case of the tubular borer, has to be removed afterwards with some care. Plattner's large borer gives a cavity with a rounded bottom like that of a crucible, which is often an advantage. These borers of Plattner are somewhat expensive, and also quite difficult to make, so that if a chemist was in a locality where they could not be bought, he would not find it an easy matter to make them for himself.

I have been using, for several years, a form of charcoal borer which works with great rapidity and perfection, and which is of the easiest construction. The holes made by this borer are cylindrical, or slightly conical, with flat bottoms. Quite lately I have devised another form which gives cavities with curved bottoms like Plattner's large borer, and which is also of the simplest construction, so that any one may, with little trouble, make one for himself.

Fig. 3.

Fig. 4.

Fig. 5.



The first of these forms is the conical tin tube of Berzelius with two modifications, one of which consists in making each base of the tube, not a complete circle but about three-quarters of a circle, as represented in figure 3, the object of which is to facilitate the removal of the core, as will be explained. The other is that the edges of each end are not like the edge of a knife, as in the tube of Berzelius, but like the edge of a saw.

Figure 4 represents a side view of this borer. At each end of the tin tube it may be seen that a portion, about a quarter of the metal, has been cut away. The middle portion of the tube is left entire, and the edges at this portion should be brazed or soldered together to insure stiffness. Figure 5 shows

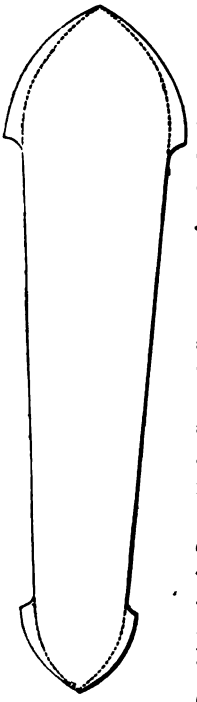
the shape of the sheet metal from which the borer is made. The edges *a* and *b* are to meet or overlap, and are to be brazed or soldered together.

This borer gives well shaped holes with remarkable quickness. When the hole has been made deep enough, the core is easily detached by pressing the tube against it, so that the core is pushed into the free portion of the groove, which corresponds to the part which has been removed from the conical tube.

If a borer of this kind is made with a large diameter, so as to leave a thick core which is not easily detached, a smaller hole may be bored in the core with a smaller instrument, after which the core is easily broken up and removed.

By alternately bending the teeth at the bases of the cone outwardly and inwardly, as in the operation called *setting* for carpenter's saws, a wider groove is left around the core, which is more easily detached when the borer is of large size.

Fig. 6.



The charcoal borer which gives cavities with curved bottoms, is made by cutting a plate of metal so as to give it the shape shown in figure 6, and bending over perpendicularly to the surface of the plate the portions at each end, which project beyond the dotted line. These projections are bent in opposite directions, as shown in figure 7. The dotted lines which show the outline of the borer, form an ogive, which gives a good shaped cavity. The portion beyond the dotted line, which is bent perpendicularly to the face of the plate, as we have already said, should have its edges sharpened with a file, to enable the borer to work more rapidly.

Fig. 7.

By pressing this borer against a piece of charcoal and turning it alternately to the right and to the left, a good cavity is obtained in a very short time. Borers of this kind should be made of pretty stout metal, as, otherwise, they become twisted by use. Tin plate known in the trade as *three cross*, is sufficiently thick for the purpose.

III. Sheet Iron Supports.

I have been using for some time, pieces of sheet iron for supporting substances before the blow-pipe flame. Sheet iron presents several ad-

vantages for this purpose, in being very common everywhere, in costing little or nothing, and in being durable, so that the same piece may be used over and over again many times. We cannot, on a plate of this kind, exhibit the action of fluxes which attack iron, but we may see with distinctness the rings or deposits that are given before the blow-pipe flame by antimony, zinc, bismuth, etc.

We may also obtain copper, lead, silver, tin, bismuth, etc., in the metallic state by the reducing flame, particularly in presence of carbonate of soda or cream of tartar.

To use sheet iron as a support, it must, in the first place, be rubbed with a piece of pumice or of Bath-brick and water until the plate looks bright. Thereby all dirt left by a previous operation, and all rust is removed. Before placing any thing for testing on the plate, it is advisable to blow the blow-pipe flame on it for a few seconds, when it becomes covered with a shining dark grey coat of magnetic oxide, on which the rings or deposits are seen with distinctness. We may, if we think preferable, cover the plate with a coat of soot, by holding it in the flame of a lamp or candle. On this coat the deposits take place equally well.

I generally use the thinnest sheet iron obtainable, which is the kind on which are taken the photographs called *ferrotypes*. Sheets of this thickness are easily bent into any convenient shape. They may be used over and over again without any perceptible diminution of their thickness.

Iron has the advantage of being relatively a poor conductor of heat, which property enables us to hold in the hand one end of a piece of sheet iron, not more than four inches long, while the other end is in the blow pipe flame. If a handle is found necessary, the piece of sheet iron may be held in a cork provided with a cut in which to insert it.

If we should want to use charcoal, I may point out that we can use a metallic plate as a charcoal holder, by making two slits crossing each other at right angles, and bending the four tongues obtained in this way, about perpendicularly to the surface of the plate. In a hole thus made in the plate, it is an easy matter to hold tightly a small piece of charcoal by bending the four tongues more or less. The ring formed by the action of the flame, may extend beyond the charcoal on the metal plate. This is in imitation of the plan proposed by Prof. Le Neve Foster, of using a plate of unglazed porcelain provided with a cavity for holding a piece of charcoal.

We may, instead of this, make a cavity in a piece of sheet iron by indentation, and fill it with a paste made by mixing the substance to be tested with an excess of charcoal powder or black flux and a little water. After heating the mass, we may obtain the metallic particles by tritu-

rating in a mortar with water, and washing away the residuary carbon. If deposits are formed they will be found on the sheet iron around the cavity.

IV.—Alloys of Lead and Tin.

The reactions presented by alloys of lead and tin before the blow-pipe flame are of such interesting nature, that I need no apology for bringing them to your attention. I am not aware that the behavior of these alloys has been specially noticed, with the exception of a brief note in an excellent paper, by Prof. Chapman, of the University of Toronto: *On some Blow-pipe Reactions*, in *Chemical News* of June 26th, 1877. In the 9th section of this paper, relating to alloys, occurs the following: "*Lead and Tin* unite readily, but the globule commences immediately to oxydize, throwing out excrescences of white and yellow oxyde. On removal from the flame, it still continues in ignition and pushes out further excrescences. The unoxydized portion, if any, is malleable."

The reactions presented by alloys of these two metals had already attracted my attention when this note was published, as I wrote at the time to Prof. Chapman, in the course of a lively, but very friendly correspondence on the occasion of his strictures on Turner's test for boracic acid.

The following experiments illustrate the points of interest in alloys of lead and tin. They were all tried with 6 decigrammes of alloy made from pure lead and pure tin.

Experiment 1st.—Melted together 3 decigrammes of lead and 3 decigrammes of tin. By continuing the heat before the blow-pipe, the alloy gives small bunches of excrescences, resembling cauliflowers. After a while, the excrescences increase progressively as the blowing continues. They are at first white, afterwards yellowish. Finally, the whole mass resolves itself into cauliflowers of deep orange color. During the formation of these excrescences, copious white and yellow fumes are given out and deposited on the charcoal.

Experiment 2d.—The six decigrammes of alloy are formed of 4 of lead and 2 of tin. In this case the reaction is violent from the very first. The bunches of cauliflower, of a deep yellow color, are formed as soon as the metals are heated. On ceasing to blow, the reaction goes on in a lively manner. Thick fumes are given out and deposited on the charcoal.

Experiment 3d.—The 6 decigrammes are formed by taking 4 of tin and 2 of lead. In this case the cauliflowers only begin to form in small bunches of white color after persistent blowing. Fumes are given out slowly, and a malleable button is left.

Experiment 4th.—Lead, 5 decigrammes; tin, 1 decigramme. After blowing a short time, the deep yellow cauliflowers form, until the whole mass is oxydized. The reaction is apparently less violent than in *Experiment 2d.*

These experiments show, that when the lead is double of the tin, the reaction takes place with more energy than with any other proportions. This is worthy of attention, because the atomic weight of lead (207) is nearly double of the atomic weight of tin (118). It makes it probable that the deep yellow cauliflower—like excrescences, are a stannate of lead. These reactions, with an alloy in which the weight of the lead is double of that of the tin, also show that this alloy, when heated, absorbs oxygen with exceeding avidity, which fact may find future applications.

Although an alloy of these proportions absorbs oxygen with great avidity, *Experiment 4th* shows, that an excess of lead does not seem to interfere in a marked degree with the reaction.

Experiments 1st and *3d* were made with excess of tin, which, contrary to what takes place with lead, interferes with the formation of the excrescences.

In *Experiment 3d*, the tin was in large excess, and the reaction was very indistinct.

A point of interest in connection with these reactions is, that, although tin does not give any fumes, and that those given out by lead are very slight, alloys of these two metals give fumes which are excessively abundant, and which might mislead a person who is not on his guard to believe that zinc or antimony are present.

As both lead and tin are ordinary blow-pipe reagents, it may be well to suggest that, when either of these bodies is suspected in a metallic substance to be tested, the addition of the other may furnish useful evidence. As the specific gravity of lead is 11.4 and that of tin 7.5, we may, without weighing, get approximately at the quantity of either of these metals to be added, by estimating the volume.

As an application of the foregoing, I may mention that the bright foil, called tin-foil, which is so extensively used in this country for wrapping around substances to be used for food, must, from its behavior before the blow-pipe, contain about twice as much lead as tin. I have not determined these proportions quantitatively.

In some works on the blow-pipe it is mentioned that, when a button of tin is strongly heated before the blow-pipe, it continues to burn after the flame is withdrawn. I have never been able to obtain this reaction with pure tin, but it takes place readily when lead is present with the tin in sufficient quantity. The tendency to oxydation is so great in a button of alloy, in which the weight of lead is double that of tin, that I do

not believe that even the most expert operator would be able to keep a button of this kind from oxydation in the most perfect reduction flame that could be obtained.

V. Reactions for Iodides, Bromides, and Chlorides.

Several years ago, Von Kobel observed that when sulphide of bismuth is heated on charcoal with iodide of potassium, a bright red coat of iodide of bismuth is obtained. From this, he proposed a mixture of equal parts of sulphur and of iodide of potassium for the detection of bismuth, which he succeeded in finding in a mineral, accompanying joseite, in which it had never been suspected. Prof. Cornwall, shortly after, proposed the same reaction for the detection of bismuth in presence of lead and antimony.

The ready formation of iodide of lead, by heating a plumbic compound with the mixture of sulphur and iodide of potassium, induced me to try the detection of iodine by heating an iodide with powdered galena. The characteristic yellow coat of plumbic iodide is deposited as soon as the flame touches the mixture. By heating chloride of sodium with galena, an abundant white coat of oxychloride (?) of lead is deposited. With bromide of potassium and galena, a white deposit of plumbic oxybromide (?) is obtained. When iodides, bromides and chlorides occur together, it is not possible to separate them by the use of galena, as a yellowish white coat is deposited when an iodide is mixed with either a bromide or a chloride, from which I have found it impossible to separate the yellow from the white.

If, however, instead of galena, we use a mixture of sulphur and bismuth, in connection with a mixture of an iodide with a chloride, we will obtain a yellowish coat and, beyond this, red streaks. At first this result is not very promising, as the yellowish deposit resembles a mixture of iodide of lead with chloride of lead. But if we let the plate cool, and, afterwards, heat the yellowish deposit very slowly and carefully, the yellowish coat will separate into an outer ring of bright red iodide of bismuth, and an inner ring of oxychloride (?) of bismuth, which, on cooling, becomes perfectly white.

If we try the same experiment with a mixture of bromide and iodide, the result is not quite so satisfactory, for, although the yellowish coat, resembling that of the preceeding case, becomes white on heating, the heat, necessary for this, causes the iodide of bismuth to be driven beyond the plate, and, although the red fumes are distinctly seen to escape, the red iodide does not remain as a witness on the plate. We may, however, by using an open tube, and by placing the mixture to be tested at one end of this tube, drive the mixed fumes of oxy-

bromide (?) and iodide of bismuth up the tube. If, afterwards, we heat slowly and carefully, the deposit near the end of the tube, to which heat was previously applied, the white oxybromide (?) will remain and the bright red fumes of the iodide will be driven further up the tube and deposited on its sides.

By means of a mixture of sulphur and bismuth we may, then, separate iodine from bromine and chlorine, but the separation of bromine and chlorine from one another is not possible with sulphide of bismuth.

XXIII.—1. A new Monochlordinitrophenol and an Aniline Derivative of a- Monochlordinitrophenol.

BY EDGAR F. SMITH, Ph. D.

When fuming nitric acid is allowed to act upon pure monochlorsalicylic acid, there is produced not only the corresponding monochlornitrosalicylic acid (in small quantities), but the nitration usually extends so far as to cause the carboxyl group to disappear, and two nitro groups enter, leaving us a monochlordinitrophenol. The formation of this latter compound was first effected in this manner by Rogers (Inaugural Dissertation, Göttingen, 1875). The phenol showed a constant fusing point of 79°–80° C., was rather insoluble in cold water, more readily soluble in warm, and crystallized from its aqueous solutions in long, yellow needles.

The salts of this acid are very beautiful; but it will suffice for our purpose to mention only the potassium derivative, which separates from its solutions in long, beautiful, silky, red needles, without any water of crystallization.

The above phenol and its potassium salt I also produced; but after working with the latter for some time, I suspected the presence of another compound, and by repeated recrystallization from aqueous solutions, I finally obtained not only the red potassium salt, but also a similar compound, which separated in large bundles, consisting of orange colored needles. These, after being completely freed from the red salt, were subjected to an analysis to ascertain their constitution.

Analysis of the red colored salt.

.1691 grms. salt, dried at 130° C., were placed in a platinum crucible, a few drops of conc. sulphuric acid added, and a gentle heat applied.

The K_2SO_4 remaining = .0264 grms., which corresponded to 15.60 p. c. potassium. The salt is anhydrous. The calculated percentage of K. in $C_6H_2Cl(NO_2)_2OK$ is 15.23 p. c. There was therefore no doubt as to the constitution of this salt.

MONOCHLORDINITROPHENOL.

Fusing point 80° C.

The free acid crystallized from aqueous solutions in long yellow needles, which fused at 80° C. and solidified again at 69° C. It is identical with the phenol of Rogers (see above), and the a-chlordinitrophenol of Faust and Saame (Annalen der Chemie u. Pharmacie, 1870, 7 Supplement-band, 2 Heft, S. 174).

Analysis of the yellow-colored salt.

Water determination: .1617 grms. air-dried salt lost upon heating at 140° C. for four hours, .0168 grms. H_2O = 10.39 p. c. 1½ mols. require 9.53 p. c.

Potassium determination: .1449 grms. dried salt gave upon evaporation with sulphuric acid .0480 grms. K_2SO4 = 14.86 potassium. From this we see that this salt is also a derivative of a monochlordinitrophenol. The formula is $C_6H_2Cl(NO_2)_2OK + 1\frac{1}{2}H_2O$.

This salt is much more soluble than the red compound. The color of the latter is so intense as to entirely obscure the yellow, which consequently is overlooked, unless great care is exercised in crystallizing the red compound.

MONOCHLORDINITROPHENOL.

Fusing point 79°–80° C.

Upon mixing a cold solution of the yellow salt with dilute nitric acid, the corresponding phenol separated in yellowish colored masses, which, upon being washed and recrystallized several times from aqueous solutions, separated in rather long, lemon-yellow colored needles. The fusing point of this compound remained constant at 79°–80° C. The point of solidification was 25° C., considerably lower than that of the acid corresponding to the red needles. In cold water, the acid is rather insoluble, readily dissolved on heating.

Another difference noticed between the free acid from the red, silky needles, and that just above described, is in the silver salts. The former

yields a soluble salt, crystallizing in long bright red colored needles, the latter one, which separates out in bronze colored needles, which possess a marked metallic lustre.

This new chlordinitrophenol is usually formed in very small quantities, therefore I have not been able to subject it to as thorough an investigation as I desired. The material, with which I worked was, however, perfectly pure; and as I have obtained the compound at various times, and the analytical result being the same on all occasions, I do not hesitate to announce the above acid as another of the many possible compounds having this composition. In regard to the position of the (NO_2) groups, I cannot give any definite information.

A- MONOCHLORDINITROPHENOL-ANILINE.

A small quantity of α chlordinitrophenol was mixed with sufficient aniline to dissolve the former in the cold. The solution was deep red in color, and imparted to the skin a rather difficultly removable yellow stain. The solution was gently warmed on a water bath for ten minutes, and the liquid then poured from the flask into a large watch glass, and allowed to cool. Hard, nodular crystals separated, which were pressed well between paper and dried by exposure to the air, then dissolved in warm water, from which, on cooling, long, curled, light-yellow colored needles separated. The fusing point of this compound, after repeated recrystallizations, remained constant at 137° C. When solutions of the compound in water are violently boiled, aniline separates out. An analysis of the substance indicated it to be a union of one mol. chlordinitrophenol with a like amount of aniline—$C_6H_2Cl(NO_2)OH.C_6H_5NH_2$.

Analysis.

0.1221 grms. dried substance burned with lead chromate gave .0188 grms. carbon = 46.19 p. c. C. The H determination was lost. The theoretical percentage of carbon demanded by the above compound is 46.22 p. c. C.

With the ammonia cobalt bases of Genth and Gibbs, a- monochlordinitrophenol yields exceedingly beautiful compounds. My results in this direction will be given later.

XXIV.—Beryllium Borate.

BY EDGAR F. SMITH, Ph. D.

Some time ago I was working with beryllium, and added to a solution of its chloride an excess of a rather concentrated borax solution. An immediate precipitation was the result. The precipitate was thrown upon a filter and washed with hot water, until a drop of the washings evaporated upon platinum foil left no residue.

The precipitate was dried and tested for boracic acid, but this was not present. Another portion of the same precipitate, subjected to an analysis, proved to be nothing more than beryllium hydrate; consequently, if the borate had been formed, the washing in hot water had decomposed it.

Another portion of the beryllium chloride was treated as above. The precipitate was brought on the filter to drain off the liquid, and then rinsed with cold water into a small flask, water added, and allowed to stand for some time, being occasionally shaken. The precipitate was then brought on to a filter and dried by exposure to the air.

Upon testing, boracic acid was found present.

Analysis gave me the following percentages of beryllium as oxide: 6.98 p. c. BeO and 6.98 p. c. BeO. The boracic acid was not estimated.

Laboratory of the University of Pennsylvania,
Phila., May 28, 1878.

THE AMERICAN CHEMICAL SOCIETY.

XXV.—Proceedings.

Regular Meeting, July 11, 1878.

Vice-President Casamajor in the chair.

The minutes of the previous meeting were read and approved.

The following were elected:

As members—Wm. Rupp, Wm. B. Phillips.

The following were proposed:

As members—W. G. Debrunner, Wm. B. Mason, Wm. H. Greene.

The papers of E. M. Johnson, on "Ferro-chromium;" G. H. Johnson, on "Ferro-manganese;" Drs. T. H. Norton and J. Tscherniac, on "Halogen Derivatives of Ethyl-acetamide," on Glycollide and on Ethoxy-acetonitrile," were read by title, and their publication left to the Committee on Papers and Publications.

Mr. Shapleigh read a paper, by Mr. M. B. Hardin, on the "Determination of Calcium as Carbonate after Precipitation as Oxalate." Mr. Casamajor read a paper on the "Verification of Graduated Glass Vessels and Areometers from 4° to 45° C." The same proposed the establishment of a loan library at the rooms of the Society; this proposition met with the approval of all present.

On motion of Dr. Goldmark, the Society adjourned to the first Thursday in August.

M. ALSBERG,
Recording Secretary.

XXVI.—On Halogen-Derivatives of Ethyl-acetamide.

By T. H. NORTON, Ph. D. and J. TSCHERNIAC, Ph. D.

Recently an article appeared (Tscherniac, *Comtes rendus*, 82, 459, 1876), showing that the dichlor-ethyl-amine first discovered by Wurtz, is distinguished from the great mass of chlorinated derivatives by the position of the chlorine atoms. When submitted to the action of zinc-ethyl, dichlor-ethyl-amine is changed directly into tri-ethyl-amine, a reaction which proves that the two atoms of chlorine are in immediate

combination with nitrogen, and that the compound may be termed an ethylated derivative of chloride of nitrogen, $N Cl_3$.

It appeared to us of interest to increase the number of these derivatives, and more especially to attempt the synthesis of a monochlorinated compound in the same series. With this intention, we have studied the action of the halogens on ethyl-acetamide:

$$\begin{matrix} \diagup H \\ N\text{-}C_2 H_3 O \\ \diagdown C_2 H_5 \end{matrix}$$

The results of these experiments, although not as clear and sharply-defined as could be desired, leave no doubt of the existence of mono-substituted compounds, in which the nitrogen is in direct union with chlorine and bromine.

The ethyl-acetamide used was prepared by mixing ethyl-acetate with ethyl-amine in an aqueous solution, and allowing the liquid to stand for two weeks. A mixture of 1 kilogr. of a 33 per cent. solution of ethyl-amine, and 660 grammes of ethyl-acetate, yielded, after this treatment, 540 grammes of ethyl-acetamide, *i. e.*, 85 per cent. of the theoretical product.

The action of dry chlorine gas on ethyl-acetamide is extremely violent. The liquid rapidly heats, becomes thick, and explosions may ensue. In order to moderate the reaction, it is necessary to place the vessel containing the liquid, in ice, and admit the chlorine slowly, interrupting the process as soon as the amount of chlorine absorbed represents an equivalent of one molecule of chlorine for one molecule of ethyl-acetamide. For this purpose it is advisable to work with quantities of from 20 to 50 grammes at a time, and weigh the vessel and its contents frequently. When performed in this manner, there is no development of H Cl during the reaction. The product of the reaction is a green liquid, smelling strongly of chlorine, and dissolves easily in water, accompanied by a slight disengagement of chlorine.

This liquid is dissolved in water containing fragments of ice, and carbonate of potassium is added in small quantities, until not only the evolution of carbonic acid has ceased, but the water present is changed into a saturated solution. The oily liquid separated by this means, and floating on the surface of the saline solution, is dried by agitation with carbonate of potassium, and contains then monochlor-ethyl-acetamide, mingled with varying amounts of ethyl-acetamide. Two samples of the reaction product at this stage gave the following percentages of chlorine:

	I	II	$N Cl (C_2 H_3 O) (C_2 H_5)$ requires
Cl..	21.23	23.77	29.21

No. I would contain 72.68 per cent. of monochlor-ethyl-acetamide and No. II, 81.37 per cent., assuming that they are mixtures of the two liquids, a supposition supported by the manner of formation, and by later experiments. On account of the lack of distinctive properties between ethyl-acetamide and monochlor-ethyl-acetamide, and the readiness with which the latter is decomposed, when exposed to the action of heat, it has hitherto been impossible to obtain the new compound pure. By the action of acids, we have succeeded but partly in removing the ethyl-acetamide present. No. 1 was dissolved in water containing a sufficient amount of H_2SO_4 to neutralize the estimated quantity of ethyl-acetamide. After agitation, the liquid was extracted with ether, and the ethereal solution dried with K_2CO_3 and evaporated on the water-bath. The residue thus obtained gave

		THEORY.
Cl....	26.14	29.21

and showed that the percentage of the chlorinated base had increased from 72.68 to 89.49. We have not succeeded, however, in obtaining by this method a liquid containing above 90 per cent.

At this degree of purity, monochlor-ethyl-acetamide, when freshly prepared, is a mobile liquid, neutral to litmus paper, and possessing a most disagreeable odor. Water, alcohol and ether dissolve it in all proportions. Carbonate of potassium separates it from aqueous solutions. When heated, a violent decomposition ensues, which continues without external assistance until the only liquid product remaining is ethyl-acetamide. If allowed to remain for a few days, it is entirely changed into a transparent syrupy liquid containing large quantities of H Cl, ethyl-acetamide and condensation products. When heated with sodic hydrate it is decomposed entirely, yielding chloroform, dichlor-ethyl-amine, ethyl-carhyl-amine, and small quantities of ethyl-amine. Similar results accompany treatment with carbonate of potassium.

The action of bromine on ethyl-acetamide is perfectly analogous to that of chlorine. It dissolves in the amide, accompanied by an evolution of heat, and the reaction product of a mixture of equal molecules is treated exactly as in the preparation of the chlorinated derivative. The resultant oily liquid is, however, heavier, and sinks to the bottom of the solution of carbonate of potassium, when not too concentrated. The same liquid is obtained when a mixture of ethyl-acetamide and a solution of bromine in bromide of potassium is heated on the water-bath. The analytical results of the brominated base pointed to the same composition and degree of purity as those yielded by the monochlor-ethyl-acetamide.

From the action of iodine a less energetic reaction was naturally to be expected. Our experiments showed that while iodine is soluble

to some extent in ethyl-acetamide, no reaction ensues, as no evolution of CO_2 followed the addition of K_2CO_3.

In regard to the formation of these brominated and chlorinated bases, it is probable that a reaction occurs quite analogous to that occurring in the preparation of dichlor-ethyl-amine from the action of hypo-chloride of lime on ethyl-amine hydro-chlorate. When exposed to the action of chlorine at a low temperature, ethyl-acetamide forms the simple addition-product $NH(C_2H_3O)(C_2H_5)Cl_2$.

And, in contact with K_2CO_3, the two following reactions:

(1) $$NH\begin{matrix}C_2H_3O\\C_2H_5\end{matrix}.\ Cl_2+K_2CO_3=KCl+KOCl+CO_2+NH\begin{matrix}C_2H_3O\\C_2H_5\end{matrix}$$

(2) $$2NH\begin{matrix}C_2H_3O\\C_2H_5\end{matrix}+2KOCl+CO_2=2NCl\begin{matrix}C_2H_3O\\C_2H_5\end{matrix}+K_2CO_3+H_2O$$

In support of this hypothesis we might mention that, when an aqueous solution of hypo-chlorite of lime is added to ethyl-acetamide, an immediate deposition of lime occurs; the same is the case, when hypo-chlorite of lime is added to a solution of ethyl-amine. On heating the mixture the monochlor-ethyl-acetamide formed is, however, at once decomposed; and when distilled, a layer of dichlor-ethyl-mine is found at the bottom of the distillate.

A more exhaustive study will show whether these singular compounds, despite their readiness to undergo decomposition, are adapted to synthetical research. The interesting fact of their existence will permit the presentation, before the society, of the results already obtained, and we hope to be able in a short time to communicate more fully the results of experiments undertaken in the same direction.

PARIS, June 1st. 1878.

XXVII.—ON GLYCOLLIDE.

BY T. H. NORTON, PH. D. AND J. TSCHERNIAC, PH. D.

IN 1854, Dessaignes (*Comptes rendus*, 38, 44) obtained, by the action of heat on tartronic acid, small quantities of a white insoluble body, which he regarded as possessing the formula $\begin{matrix}CH_2\diagdown\\|\\C\ O\diagup\end{matrix}O$, and considered it to bear the same relation to glycollic acid that lactide does to lactic acid. The easy transformation of this compound, by means of ammonia or alkalies, into glycollamide or glycollates warranted this view, and the name glycollide, assigned to the compound by its discoverer. He described it as a white powder, melting at 180°, impossible to obtain entirely free from water, and slowly changed by the action of boil-

ing water into glycollic acid. The same body was found by Heintz (*Poggendorf's Annalen*, 115, 280 and 452; 1861) among the products resulting from the exposure of glycollic acid to a temperature of 240°, as well as from the action of glycollate of sodium, on monochlor-acetic acid, or on ethyl-monochlor-acetate. Kekulé (*Liebig's Annalen*, 105, 288; 1858) obtained, by heating potassium monochlor-acetate to 120°, small quantities of a white powder, which he considered to be glycollide. The quantity was, however, too small and impure to analyze.

The degree of interest attached to glycollide, on account of its simple formula—$C_2H_2O_2$—and its position as the anhydride of glycollic acid, as well as its evident adaptation for a variety of syntheses, led us to seek out a method, by which it could be easily prepared in large quantities and in a state of purity. For this purpose no reaction appeared better adapted than the decomposition of a salt of monochlor-acetic acid:

$$\begin{matrix} CH_2Cl \\ | \\ COONa \end{matrix} = NaCl + \begin{matrix} CH_2 \\ | \\ CO \end{matrix} \diagdown\!\!\diagup O$$

The unsatisfactory results obtained by Kekulé in his experiments with monochlor-acetate of potassium, we regarded as due to the presence of water of crystallization in the salt, it being impossible, as is well known, to free the salts of this acid from water by means of heat, without causing not only a hydration of the glycollide formed, to glycollic acid, but also the entire decomposition of the greater portion of the substance. It was necessary then, first of all, to find a method of preparing an anhydrous salt of monochlor acetic acid.

SODIUM MONOCHLOR-ACETATE.

For this purpose we took advantage of the insolubility of the sodium salt in alcohol. Sodium was dissolved in fifteen times its weight of absolute alcohol, and a concentrated solution of monochlor-acetic acid in absolute alcohol, was added to the sodium ethylate until the liquid showed a neutral or slightly acid reaction. The monochlor-acetate of sodium, precipitated in this manner, forms, with the alcohol, a white pasty mass; but settles out after a few hours' standing. It can then be filtered, pressed and placed in the air-bath to dry. Thus prepared the salt is perfectly pure and free from water. An analysis gave:

	Found	Calculated for $C_2H_2ClO_2Na$.
NaCl.....	50.23 per cent.	50.21 per cent.

It forms a light, white powder, exceedingly soluble in water.

PREPARATION OF GLYCOLLIDE.

In order to decompose sodium monochlor-acetate into sodium chloride and glycollide, the salt, after coming from the press, is spread in thin layers on plates and heated in the air-bath. The temperature

can gradually be raised from 100° to 150° during the course of four to five hours, and after remaining at 150° for two to three hours longer, the operation can be regarded as complete. It is advisable to stir the layers from time to time, to prevent caking. The essential elements in the reaction are a gradual elevation of the temperature, and a fine division of the substance during the entire process. When these precautions are not observed, the entire quantity is suddenly changed into a viscous, puffy, black mass, which emits most irritating vapors. In such cases the decomposition is not so extensive as it appears. When promptly interrupted the mass solidifies to hard crusts, which can be pulverized and reheated. The glycollide obtained at the end of the process, is of a gray color, and sufficiently pure for most purposes.

After the sodium monochlor-acetate has been heated as above described, about 80 per cent. of the amount is changed according to the reaction.

$$\begin{matrix} CH_2Cl \\ | \\ COONa \end{matrix} = NaCl + \begin{matrix} CH_2 \\ | \\ CO \end{matrix} \diagdown\!\!\diagup O$$

Heating above 150° does not appear to add to this yield. When heated at 135°, it is not much less; and even at 125°, a considerable quantity is transformed.

On being removed from the air-bath, the mass is finely pulverized, boiled for a short time in water and then filtered. The residue of glycollide remaining on the filter is washed with cold water, until the filtrate gives no reaction with silver nitrate. It is then quite pure, and can be easily freed from water by heating up to 200°.

An analysis of the glycollide, prepared as above, gave:

	Found	Calculated for $C_2H_2O_2$.
C.....	41.36	41.38
H.....	3.63	3.45

Glycollide, when pure, is a light, white powder, of an insipid taste. It melts at 220°, and not at 180°, as stated by Dessaignes. In cold water it is almost perfectly insoluble, the liquid, when containing it in suspension, not affecting litmus paper. In boiling water it is slowly changed into glycollic acid:

$$\begin{matrix} CH_2 \\ | \\ CO \end{matrix} \diagdown\!\!\diagup O + H_2O = \begin{matrix} CH_2OH \\ | \\ COOH \end{matrix}$$

The reaction is rapidly effected by heating the mixture of glycollide and water above 100° in a sealed tube; the solid substance disappears in the course of a few hours, and the resultant acid liquid, when neutralized with baric hydrate, and evaporated, deposits hard crystalline crusts of barium glycollate. The analysis gave:

	Found	Calculated for $(C_2H_2O_3)_2Ba$.
Ba.....	47.85	47.66

Glycollide is insoluble in alcohols, ether, acetic acid, aceton, benzene and bisulphide of carbon. When heated with acetic anhydride, in a sealed tube, at 200°, a small quantity was dissolved, and separated on evaporating the filtered liquid. It dissolves in boiling nitro-benzene, but separates as an amorphous precipitate, when the solvent is cooled but slightly below the boiling point. When gently warmed with solutions of ammonia, caustic soda or caustic potash, it is readily dissolved, forming the corresponding glycollates, as stated by Dessaignes.

When submitted to dry distillation, glycollide is decomposed into water, carbon, and carbon monoxide:

$$C_2H_2O_2 = H_2O + C + CO.$$

The same reaction ensues when it is heated with phosphoric anhydride, even when mingled with sand in order to moderate the reaction. In both cases the amount of carbon monoxide formed was, however, notably less than the theory would require.

Although aqueous solutions of the alkaline hydrates dissolve glycollide with such ease, we have not succeeded in obtaining reactions with the solutions of the corresponding sulph-hydrates. Sulphuretted hydrogen is likewise without effect on this anhydride, no alteration in weight occurring, when it is heated in this gas at various temperatures up to 200°.

Inviting as the formula of glycollide appears for the formation of compounds in the propyl, butyl, and other higher groups of the fatty series, all attempts at such syntheses have hitherto failed to give the desired results. When heated with acetic acid, or acetic anhydride, or formic acid, or an aqueous solution of hydrocyanic acid, at 200°, in sealed tubes, no reaction ensued, with the exception of the last mentioned case, in which simply glycollic acid was formed.

Experiments in other directions gave more satisfactory results.

PREPARATION OF ETHYL-GLYCOLLATE FROM GLYCOLLIDE.

If ethyl alcohol and glycollide be mixed in the proportions of four to five, and heated for several hours in a sealed tube at 200°, the glycollide is entirely dissolved, and there is no pressure in the tube when cold. On distillation, the greater portion of the colorless liquid passed over at 154°–156°. A small fraction was collected between 160° and 195°, and a residue of decomposition products remained after the distillation. The main portion boiling constant at 154°–156°, after four distillations, was submitted to analysis and gave:

	Found	Calculated for $C_2H_2O_2C_2H_5$.
C	46.77	46.16
H	8.44	7.69

Ethyl-glycollate was first obtained by Heintz (*Liebig's Annalen*,

123, 212; 1861), who prepared it by the action of ethyl monochloracetate on sodium glycollate at 130°, but failed to describe the physical properties. Fahlberg (*Journal für Prakt Chemie* [2], 7, 329; 1873) obtained the ether by heating together equivalent quantities of calcium glycollate and potassium ethyl-sulphate at 170°. He found the boiling point to be 150°, and stated that the analytical results were widely divergent on account of the readiness with which the ether was decomposed.*

This ether, when prepared by the direct combination of alcohol and glycollide,

$$C_2H_5OH + \begin{matrix} CH_2 \\ | \\ CO \end{matrix}\!\!\diagdown\!\!O\!\!\diagup = \begin{matrix} CH_2OH \\ | \\ COOC_2H_5 \end{matrix}$$

forms a colorless mobile liquid, boiling constant at 154°–156°. It is soluble in less than five parts of water, but is completely separated from its aqueous solution by the addition of potassium carbonate. It has an agreeable odor and a burning taste. It is not easily inflammable, and burns slowly with an almost colorless flame.

An experiment made in the hope of obtaining ethyl-glycollate of ethyl, by heating together equivalent quantities of glycollide and ethylic ether in a sealed tube, gave no results; the glycollide remaining unattacked even at temperatures above 200°.

PREPARATION OF GLYCOL-ETHYL-AMINE FROM GLYCOLLIDE.

When an equivalent quantity of glycollide is added to ethyl-amine at 0°, and then slightly warmed, it is completely dissolved:

$$\begin{matrix} CH_2 \\ | \\ CO \end{matrix}\!\!\diagdown\!\!O\!\!\diagup + NH_2C_2H_5 = \begin{matrix} CH_2OH \\ | \\ CONHC_2H_5 \end{matrix}$$

The resultant liquid is of a syrupy consistence, possesses a reddish-brown color, boils from 245° to 275°, and coincides, in all other respects, with the glycol-ethyl-amine obtained by Heintz (*Liebig's Annalen*, 129, 27; 1864) from the action of ethyl-amine on ethyl-glycollate.

GLYCOL-PHENYL-AMINE.

Glycollide dissolves easily in aniline when heated to 130°. It is desirable to take slightly more than an equivalent of glycollide in order to facilitate the purification. After keeping the mixture at the above temperature for a short time, it is boiled with water and filtered. On

* It would, perhaps, be well to direct attention to the strange mistake on page 570 of the 2d Supplement of Watts' Dictionary, where Henry's ingenious method for preparing the ethyl ether of ethyl glycollic acid is changed into a preparation of ethyl-glycollate; and the vapor density of the former—6.977 at 150°—suffers a transformation into a *specific gravity* of 0.977 at 150°. (!)

cooling, the solution deposits a mass of white crystals, which are easily purified by recrystallization from water. When deposited from a hot, concentrated solution, the crystals take the form of radical bunches of long slender needles, which melt at 108°. A cold, concentrated solution, when allowed to evaporate spontaneously, yields large prismatic crystals, belonging to the clino-rhombic system, and melting at 92°. Apart from the difference in the melting point, the two varieties of crystals coincide in their chemical and physical properties, and possess the same composition.

	Found					Calculated for $C_2H_3O_2.NH.C_6H_5$.
	1	2	3	4	5	
C....		64.08	63.12	63.90	63.80	63.51
H....		6.40	6.30	6.33	6.40	5.96
N. ..	9.85					9.27

The first three analyses are of crystals melting at 108°. The last two of crystals melting at 92°.

Glycol-phenyl-amine dissolves in its own weight of water at 100°, and in $17\frac{1}{2}$ parts of water at 20°. It dissolves easily in alcohol, ether, chloroform, benzene, and other organic liquids. Alkalies decompose it, forming aniline and glycollates. Its aqueous solution dissolves oxide of silver. The resultant derivative crystallizes in fine needles, but is too easily decomposed to be obtained pure.

PREPARATION OF NITRILES FROM AMIDES.

We transformed a quantity of glycollide into glycollamide by solution in ammonia and evaporation, and have sought in various ways by dehydration, to obtain a glyco nitrile, $NC.CH_2OH$. Thus far the experiments have been fruitless. Phosphoric anhydride carbonizes the amide, and penta-sulphide of phosphorus yields derivatives containing sulphur. In this connection we have endeavored to simplify the preparation of nitriles, by the substitution of a re-agent more convenient to use than the phosphoric compounds. For this purpose we have found quicklime well adapted. Benzamide and acetamide, when heated with equivalent quantities of this dehydrating agent in a sand-bath, give the corresponding nitriles in quantities amounting usually to one-third of the theoretical yield.

PARIS, June 6th, 1878.

XXVIII.—On Ethoxy-Acetonitrile.

BY T. H. NORTON, Ph. D., and J. TSCHERNIAC, Ph.D.

In a recent communication to the Society we have referred to experiments undertaken with the view of dehydrating glycollamide, and obtaining thereby an oxy-acetonitrile:

$$\begin{matrix}CH_2OH\\ |\\ CONH_2\end{matrix} = H_2O + \begin{matrix}CH_2OH\\ |\\ CN\end{matrix}$$

Negative results were given by all the re-agents used—phosphoric anhydride, penta-sulphide of phosphorus, and lime. It appeared probable to us, that the impossibility of obtaining the desired nitrile by the above reaction was due to the instability of the hydroxyl group, and that a more successful result could be expected from the dehydration of a derivative of glycollamide, in which the hydroxyl group was replaced by ethoxyl or a similar group. For this purpose we have taken ethyl-glycollamide, and submitted it to the action of phosphoric anhydride. The result has fully confirmed our expectations.

This amide was prepared from monochlor-acetic acid by successive changes into mono-chlor-acetate of ethyl, $\begin{matrix}CH_2Cl\\ |\\ COOC_2H_5\end{matrix}$, ethyl-glycollate of ethyl, $\begin{matrix}CH_2OC_2H_5\\ |\\ COGC_2H_5\end{matrix}$, and ethyl-glycollamide, $\begin{matrix}CH_2OC_2H_5\\ |\\ CONH_2\end{matrix}$.

Ethyl-glycollate of ethyl was first prepared by Heintz (*Liebig's Annalen*, 130, 27, 1864), by the action of iodide of ethyl on ethyl-glycollate of sodium. Henry (*Berichte der deutschen chemischen Gesellschaft*, 4, 706, 1871) recommends for this preparation the action of sodium ethylate on mono-chlor-acetate of ethyl, a method, which, with some slight alterations, we have found to give excellent results. Mono-chlor-acetate of ethyl (100 parts) is added in small quantities to a solution of 18 parts of sodium in 250 parts of absolute alcohol. In order to prevent the formation of secondary products as much as possible, the vessel containing the latter is immersed in ice-water. An immediate precipitation of NaCl follows the addition of the ether, and the reaction is completed by heating for several hours in the water-bath, with an inverted condenser. The entire mass of liquid is then distilled off from the NaCl, in an oil bath, and submitted to fractional distillation. The ether, which boils at 155°, is easily separated from the alcohol, and obtained quite pure after two or three distillations. We obtained in this way 65–70 per cent. of the theoretical yield.

Ethyl-glycollamide,* $\begin{matrix}CH_2OC_2H_5\\CONH_2\end{matrix}$, was first prepared by Heintz (*Liebig's Annalen*, 129, 27, 1864), who added a large excess of aqueous solution of ammonia, mixed with alcohol, to ethyl-glycollate of ethyl, and allowed the mass to evaporate over sulphuric acid. We have found the best method of preparation to be the following: The estimated amount of concentrated ammonia solution is added to the ether, and the mixture allowed to stand for a week in a closed flask. It can then be evaporated over sulphuric acid in a vacuum, or simply fractionated, the high boiling point of the amide permitting an easy separation. We obtained in this manner from 100 grammes of ethyl-glycollate of ethyl, 58 grammes of ethyl-glycollamide. In addition to the properties of this body, as given by Heintz, we can state, that it possesses a constant boiling point, passing over without decomposition at 225° (bar. 758 mm.)

For the preparation of ethoxy-acetonitrile, perfectly dry phosphoric anhydride is intimately mixed with two-thirds of its weight of ethyl-glycollamide—likewise perfectly dry and finely powdered—in a large flask. For 100 grammes of the mixture, a litre flask is requisite to provide for the foaming, which accompanies the reaction. The flask is supplied with a tube to collect the distillate, and heated on the sand-bath. The contents gradually melt and form a puffy mass, while a liquid slowly gathers in the recipient. The heat is slowly increased until no more liquid appears, when the operation is terminated. The distillate thus obtained, which usually amounts to about 40 per cent. of the weight of ethyl-glycollamide used, is nearly pure ethoxy-acetonitrile, almost the entire mass distilling between 132° and 134°. The formation is shown by the following reaction:

$$\begin{matrix}CH_2OC_2H_5\\CONH_2\end{matrix} = H_2O + \begin{matrix}CH_2OC_2H_5\\CN\end{matrix}$$

The nitrile thus prepared was distilled three times, and the middle fraction of the quantity collected, between 132° and 133°, was subjected to analysis.

	FOUND.		CALCULATED FOR C_4H_7NO.
C.....	55.82	.....	56.47
H.....	8.63	.....	8.23
N.....	——	16.94	16.48
O.....	——	——	18.82

Ethoxy-acetonitrile is a limpid, colorless liquid. It has a peculiar

* In Watts' Dictionary, 1st Suppl. p. 647, this name is applied to the isomeric glycol-ethyl-amine—discovered at the same time by Heintz—while ethyl-glycollamide itself is passed by in silence. Compare Wurtz Dictionnaire de Chimie, 2, 1613.

odor, recalling that of hydrocyanic acid, while still strongly ethereal; and a burning taste. It is insoluble in water, but easily soluble in alcohol, ether, etc. It boils without suffering decomposition at 132° to 133°, under a pressure of 758.5 mm. The specific gravity at 20° is 0.9093.

The general connections existing between the nitriles on the one hand, and the amines and alcohols on the other, show the importance of this class of bodies for organic synthesis, and the possibility of producing from any nitrile the corresponding amine and alcohol. Our efforts shall be directed at once to establish how far the compound just described is obedient to the general laws governing the nitriles hitherto known, and to extend these investigations to the homologues of ethoxyacetonitrile, the syntheses of which we shall likewise undertake.

Paris, June 10th, 1878.

XXIX.—On the Determination of Calcium as Carbonate after Precipitation as Oxalate.

By M. B. HARDIN.

The following modification of the usual method of converting calcium oxalate into carbonate in the course of analysis, has been used in this laboratory for the last two years.

The process is based upon the fact that while calcium carbonate is not altered, calcium oxalate is converted into carbonate when ignited in an atmosphere of carbon dioxide.

The following mode of proceeding has given uniformly accurate results even in the hands of beginners:

The calcium oxalate separated from filter is placed in a platinum crucible.

The filter is burned; the ash is collected in the crucible lid, treated with a little water, and, after a few minutes, with two or three drops of a strong solution of ammonium carbonate, dried in water-bath, very gently ignited, and returned to water-bath, where it is kept until needed. The crucible containing the bulk of the oxalate, is covered with the perforated lid of a Rose's crucible, and carbon dioxide transmitted in a moderate and steady stream, which is to be maintained until the process is completed.

The gas is first passed for five minutes in the cold. The crucible is then gently heated, not to redness, for five minutes, by placing a Bunsen's burner, with lowered flame, in a suitable position. (No difficulty presents itself here, as any temperature between 205° C. and a red heat, will answer.)

The heat is next gradually raised to bright redness, and the crucible kept at this temperature for about ten minutes.

At the end of this time, the lamp is removed, and, when the crucible has cooled below redness, the current of carbon dioxide is stopped, the perforated lid taken off, the platinum cover containing the ash laid loosely on, and the crucible placed in the desiccator.

If the resulting carbonate is not white, or nearly so, it must be re-ignited in carbon dioxide.

Direct experiments with the process gave the following results:

1st. A sample of powdered Iceland spar was ignited in carbon dioxide.

WEIGHT OF CALCITE TAKEN.	WEIGHT AFTER IGNITING 10 MIN.	WEIGHT AFTER REIGNITING 10 MIN.
Grm.	Grm.	Grm.
1.0000	0.9991	0.9991

The ignited carbonate was shown, by turmeric paper, to be free from caustic lime.

2d. Specimens of a specially prepared and pure calcium oxalate were ignited as described above.

CALCIUM OXALATE (DRIED AT 100° C.) TAKEN.	CALCIUM CARBONATE OBTAINED.	CALCIUM CARBONATE CALCULATED.
Grm.	Grm.	Grm.
1.0003	0.6851	0.6851
0.9998	0.6847	0.6848
0.9994	0.6845	0.6845

The carbonate was in each case free from caustic lime.

3d. Samples of powdered Iceland spar were ignited in carbon dioxide, weighed and dissolved in hydrochloric acid. The calcium was precipitated as oxalate in the usual way, and the several precipitates were ignited as above.

CALCITE TAKEN.	CALCIUM CARBONATE OBTAINED.	LIME FOUND.	LIME CALCULATED.
Grm.	Grm.	Per cent.	Per cent.
0.9991	0.9991	56.	56
0.5018	0.5016	55.98	"
0.6407	0.6406	55.99	"
0.5723	0.5721	55.98	"
0.6013	0.6013	56.	"

To these results may be added one recently obtained by Mr. E. A. Gibbs, a student in this laboratory, in making, for the very first time, an analysis of calcite:

CALCITE TAKEN.	CALCIUM CARBONATE OBTAINED	LIME FOUND.	LIME CALCULATED.
Grm.	Grm.	Per cent.	Per cent.
0.4984	0.4985	56.01	56

In every one of these cases, the resulting carbonate was white, or barely tinged with gray, and perfectly free from caustic lime.

XXX.—Verification of Graduated Glass Vessels and Areometers from 4° to 45° C.

BY P. CASAMAJOR.

The graduated glass vessels, used in laboratories, are generally divided into cubic centimeters, and the volumes designated are supposed to be correct at a certain temperature, taken as a normal, which is generally 15° C.

I propose this evening to give a table (No. 2) for the verification of these graduations at all degrees of temperature, from 4° to 45° C., in which will be found, for every degree, the weight of distilled water which will occupy a space which at 15° C. is equal to 100 c.c.

Afterwards I will consider the verification of the graduations of areometers.

It is needless to add that the methods used for the verification can be easily applied to the graduation of measuring vessels and of areometers.

Let us suppose that we have a graduated flask, capable of holding 100 c.c. of water at 15° C., when filled up to a line etched on its neck, and that we wish to know if this graduation is correct. To ascertain this, we may fill up the flask with distilled water, at the temperature of 15° C., up to the line on its neck, and find whether the weight of the water is the proper weight. This leads us to inquire: What is the weight of distilled water which, at 15° C., will occupy exactly 100 cubic centimeters?

For the solution of this question, we have to make use of Table No. 1, which has already been published twice in our Proceedings,* but which must be given again in this place, as it is to be the base of all our calculations. In this table, as here given, the temperatures range from 4° to 45° C., while, as previously published, the lowest temperature was 5°.

In the first column of this table are the temperatures for every degree, from 4° to 45° C. Opposite to these, in the second column, are to be found, for every degree, numbers representing the absolute expansions of 1 c.c. of water, starting from 15° C. as a normal. For the degrees below 15° the numbers in this column represent absolute contractions, and are to be subtracted. We may see, in the second column, that if we take 1 c.c. of water, and heat it to 16°, it will become 1.000173 c.c.; if heated to 25°, it will become 1.002179 c.c, &c. If,

* *Proceedings of the American Chemical Society*, vol. I, First Part, p. 193; Part Second, p. 20. Also see *American Chemist* for January, 1877, p. 251; *Chemical News*, vol. XXXV, p. 161, and *Moniteur Scientifique*, vol. VII, 3d series, August, 1877, p. 862.

instead of heating, the temperature is lowered from 15° to 14°, 1 c.c. of water will become 1 — 0.000150 = 0.999850 c.c.; if cooled to 7°, it will become 1 — 0.000820 = 0.999180 c.c., &c.

For the methods used in obtaining these numbers I must refer you to the Proceedings of this Society—vol. I, First Part, p. 193.*

TABLE No. 1.

Total expansions from 15° C.

Degree Centigrade.	Absolute Expansion.	Relative Expansion.	Degree Centigrade.	Absolute Expansion.	Relative Expansion.
4°	0.000887	0.000600	25°	0.002179	0.001919
5°	0.000878	0.000612	26°	0.002445	0.002159
6°	0.000856	0.000622	27°	0.002717	0.002405
7°	0.000820	0.000612	28°	0.002995	0.002657
8°	0.000772	0.000590	29°	0.003279	0.002913
9°	0.000706	0.000550	30°	0.003569	0.003179
10°	0.000622	0.000492	31°	0.003869	0.003453
11°	0.000524	0.000420	32°	0.004181	0.003739
12°	0.000412	0.000334	33°	0.004503	0.004035
13°	0.000288	0.000236	34°	0.004836	0.004342
14°	0.000150	0.000124	35°	0.005180	0.004660
15°	Normal	Normal	36°	0.005533	0.004987
16°	0.000173	0.000147	37°	0.005895	0.005323
17°	0.000357	0.000305	38°	0.006265	0.005667
18°	0.000551	0.000473	39°	0.006644	0.006040
19°	0.000756	0.000652	40°	0.007032	0.006382
20°	0.000971	0.000841	41°	0.007428	0.006752
21°	0.001119	0.001039	43°	0.007832	0.007130
22°	0.001428	0.001246	43°	0.008244	0.007516
23°	0.001670	0.001462	44°	0.008664	0.007910
24°	0.001920	0.001686	45°	0.009092	0.008312

The numbers of the third column represent the total *relative* expansions of 1 c.c. of water, starting from 15° C. as a normal. They were obtained by subtracting the number 0.000026, the co-efficient of expansion of glass for 1° C. as many times, from the quantities in the second column, as there are units between the corresponding number of degrees and 15° C. The numbers in this third column represent the apparent expansion of water in glass vessels.

If we wish to know the weight, in grammes, of 100 c.c. of distilled water at 15° C., we must refer to the definition of the gramme, which is: *the weight of* 1 *c.c. of distilled water at* 4° *C., taken in vacuo.*

* Also *American Chemist, loc. cit.; Chemical News*, vol. XXXV, p. 161; and *Moniteur Scientifique* for March, 1877, p. 237.

By referring to the second column of Table No. 1, we may see that if we take 1 c.c. of water at 15° C., and lower the temperature to 4°, the cubic centimeter of water becomes $1 - 0.000887 = 0.999113$ c.c., which will weigh *in vacuo* 0.999113 grammes; therefore, the weight of 100 c.c. of distilled water at 15° C. and *in vacuo* is 99.9113 grammes. To make this result of practical value, we must proceed to eliminate the two conditions of weighing *in vacuo* and at the temperature of 15°.

It is no easy matter to keep liquids for any length of time at a temperature different from that of the room in which we operate, and, when the temperature of the liquid is much lower than that of the room, condensation of moisture takes place on the surface of the vessel which holds the liquid, which circumstance interferes with accurate weighing.

As the most favorable condition is that the temperature of the liquid be the same as that of the room, I give, in the second column of Table No. 2, the quantity of distilled water to be weighed *in vacuo* at every degree from 4° to 45° C., so that the volume shall be that which in a glass vessel, at 15° is equal to 100 c.c. We will afterwards eliminate the condition of weighing *in vacuo*.

If we had a flask made of a material which would not expand by the action of heat, and this flask had a volume of 100 c.c., we could calculate from the second column of Table No. 1, for every degree of temperature above and below 15°, the weight of water which is equivalent to 99.9113 grammes at 15°, or, in other words, the weight of water which would occupy 100 c.c. For instance, the weight at 16° would be $99.9113 \times \frac{1}{1.000173}$, and so on for every temperature above 15°. For 14°, we would find $\frac{99.9113}{1-0.000150}$, and so on for every temperature below 15°.

TABLE No. 2.

Weight, in grammes, of distilled water, occupying a volume, in a glass vessel, equal to 100 *c.c. at* 15° *C.*

Degrees Centigrade.	Weight of distilled water *in vacuo*.	Weight of distilled water at pressure =760 mm. of mercury.	Degrees Centigrade.	Weight of distilled water *in vacuo*.	Weight of distilled water at pressure =760 mm. of mercury.
4°	99.9712	99.8595	25°	99.7200	99.6163
5°	99.9723	99.8610	26°	99.6960	99.5927
6°	99.9735	99.8626	27°	99.6716	99.5686
7°	99.9723	99.8618	28°	99.6465	99.5439
8°	99.9702	99.8601	29°	99.6211	99.5189
9°	99.9662	99.8565	30°	99.5945	99.4926
10°	99.9604	99.8512	31°	99.5674	99.4658
11°	99.9532	99.8444	32°	99.5390	99.4377
12°	99.9446	99.8362	33°	99.5097	99.4087
13°	99.9348	99.8268	34°	99.4793	99.3787
14°	99.9237	99.8161	35°	99.4479	99.3476
15°	99.9113	99.8041	36°	99.4155	99·3155
16°	99 8965	99.7896	37°	99.3723	99.2726
17°	99.8818	99.7753	38°	99.3482	99.2488
18°	99.8640	99.7578	39°	99.3114	99.2124
19°	99.8462	99.7404	40°	99.2777	99.1790
20°	99.8273	99.7218	41°	99.2412	99.1428
21°	99.8075	99.7024	42°	99.2040	99.1060
22°	99.7869	99.6821	43°	99.1660	99.0682
23°	99.7654	99.6610	44°	99.1272	99.0298
24°	99.7431	99.6390	45°	99.0877	98.9906

As, however, we have to deal with a glass flask, whose volume varies with the temperature, we must use the 3d column of Table No. 1, the numbers of which were obtained, as we have already said, by subtracting from the corresponding numbers in the second column the number 0.000026, the co-efficient of expansion of glass as many times as there are units in the difference between the number expressing the degree of temperature and 15° C.

If we have a glass vessel holding 1 cubic centimeter of water at 15°, and if we mark the place on its neck which corresponds to the surface of the liquid, when we come to raise the temperature of the vessel and its contents to 16°, the liquid will expand, as we have said, to 1.000173 c.c.; but the volume, marked on the glass vessel, will itself expand to 1.000026 c.c., and the expansion of the liquid beyond the line on the glass would be the difference = 0.000147 c.c., and the weight of liquid below the line would be $\frac{0.999113}{1.000147}$ grammes. If the flask is

capable of holding 100 c.c. at 15°, up to a line on its neck, the weight up to that line at 16° would be $\frac{99.9113}{1.000147}=99.8965$. By proceeding in the same manner for all temperatures up to 45°, we obtain a series of numbers, expressing the weight in grammes, taken *in vacuo*, which will occupy a volume in a glass vessel, which, at 15°, is equal to 100 cubic centimeters. These we place in the 2d column of Table No. 2.

For temperatures below 15°, we may notice, that if we cool down 1 c.c., from 15° to 14°, the volume is reduced to $1-0.000124=0.999876$ c.c., and, consequently, to fill up the flask up to the mark representing 100 c.c. at 15°, we must weigh $\frac{99.9113}{0.999876}=99.9237$ grammes. In the same manner we obtain the weights for temperatures down to 4° C., and we also place the numbers thus obtained in the second column of Table No. 2.

We may now proceed to eliminate the condition of weighing *in vacuo*, by considering that a body, placed in a medium, loses a weight equal to that of the medium displaced.

Therefore, if we subtract, from the numbers of the second column, the weight of 100 c.c. of air at the atmospheric pressure, and at the various temperatures from 4° to 45° C., we obtain quantities expressing the number of grammes of distilled water, which, at the pressure of the atmosphere, would occupy a space in a glass vessel, which, at 15°, is equal to 100 c.c. We have done this for the pressure equal to 760 millimeters of mercury, the normal pressure of the atmosphere. At this pressure, and at 0 degree C., 100 cubic centimeters of air weigh 0.1293 grammes, and we might take this weight as the base of our calculations; but we may take into account the weight of air displaced by the brass weights, placed on the other pan of the balance, which is to be subtracted. As all the larger weights used by chemists are made of brass, where specific gravity is 8, we should take $\frac{1}{8}$ of $0.1293=0.1132$ grammes, which is the difference of the weight of air displaced at 0° C. by 100 c.c. of water, and by the corresponding brass weights.

The expansion of air for every degree Centigrade is equal to 0.00366, and, therefore, the weight of air, which, at every degree of temperature, occupies the same volume as 0.1132 grammes at 0, is:

$$\frac{0.1132}{1+0.00366\ t},$$

t being the degree Centigrade.

By subtracting the numbers thus obtained from those of the second column of Table No. 2, we obtain in a third column, the number of grammes of distilled water, which, at the normal pressure of the atmosphere, and for every degree from 4° to 45° C., we are to weigh, so as

to fill up a volume in a glass vessel, which, at 15°, is equal to 100 cubic centimeters.*

In conclusion of this first part, which relates to graduated measuring vessels, I propose to repeat what I have said on a previous occasion (*Proceedings of A. C. S.*, Vol. I, 2d part, p. 23, foot note), to show the accuracy of the numbers in Table No. 1. I do this because, if I have been successful in explaining what I had to say, you must be satisfied that, if Table No. 1 is correct, Table No. 2 is equally so.

A long time before calculating Table No. 1, I found directly, by experiment (*American Chemist*, June 1874, p. 449), that the total relative expansion of water from 5° to 45° C. was 0.00021. Now, if we calculate this same quantity from Table No. 1, by adding the total contraction at 5° (0.000612) to the total expansion at 45° (0.008312), the sum 0.008924, divided by 40, will give 0.000223, which is as near 0.000210 as could be expected, if we remember that the extreme numbers, 0.000612 and 0.008312, contain the accumulated errors of this table.†

VERIFICATION OF AREOMETERS.

The areometer, whose correctness we have to verify, may either indicate specific gravities, or its scale is one whose divisions are equal to one another. In the latter case, the specific gravity corresponding to any division of the scale may be found by the formulas which were given in the paper *On Areometers*, which I had the honor of reading before this Society in the month of April of last year.

In these formulas, N is the total number of degrees of even scale, d a degree of this scale, and P the corresponding specific gravity.

We have:

$$N=\frac{Pd}{P-1}$$

$$P=\frac{N}{N-d}$$

$$d=N-\frac{N}{P}.$$

If, for instance, we take for the specific gravity of sulphuric acid, H^2SO^4, the number 1.845, found by Dr. Ure, and use Beaumé's areometer, in which this specific gravity corresponds to 66°, we have $N=\frac{1.845\times 66}{0.845}=144.02$, which is as near as possible the generally ac-

* As the capacity equal to 100 c.c. at 15° in a glass vessel varies with the temperature, a further correction might be made for this variation, but it is so insignificant as not to affect the 4th decimal at 45° C.

† The table of Dr. Hermann Kopp, agrees still more closely with the result I found, it gives for the mean expansion for 1°, between 4° and 45° C., 0.000209. (See *American Chemist*, June 1874, p. 449.)

cepted standard for Beaumé's areometer in Germany and in this country, in which N=144. As, however, graduation of even scale can never be anything but a conventional matter, any other number, N, founded on any other specific gravity, as determined by any other chemist, would be equally good, provided this other number, N, was generally accepted.

In the paper to which I have referred, mention was made several times of the verification of areometers by ascertaining the corresponding specific gravity by the balance; but I did not enter into any details as to the manner of taking these specific gravities. I propose to do this now, as the subject is one of great importance, and more open to misunderstandings than I had supposed.

We must, in the first place, recall the definition of the specific gravity of a liquid, which is: *the quotient obtained by dividing the weight of a certain volume of the liquid by the weight of the same volume of water, both weights being taken at the same temperature and the same pressure.*

If our measuring vessels retained a constant volume at all temperatures, and if the dilatation of all liquids was the same for equal variations of temperature, the specific gravity of a liquid, which is its weight, compared with that of water, under the same volume, would be the same at all temperatures. If at 4°, and *in vacuo*, 100 c.c. of a liquid, whose specific gravity is 1.5, weigh 150 grammes, at 25°, and *in vacuo*, the weight of 100 c.c. of water being $\frac{1}{1.003067}=99.69$ grammes, the weight of 100 c.c. of the liquid in question would be $99.69\times1.5=$ 149.535 grammes.

As the volumes of glass vessels increase by heat, and as the expansions of liquids are different for the same variation of temperature, it is customary, in areometers, as in measuring vessels, to specify that the graduations are taken at a certain temperature, which is generally 15° C.

For the purpose of testing areometers, and, in general, for taking the specific gravities of liquids at 15°, it is very convenient to have a glass flask, which, at 15° and at the pressure of the atmosphere, holds exactly 100 grammes of distilled water up to a line on its neck. Then the number of grammes gives directly the specific gravity, at 15°, of any liquid, occupying the same space, without further calculation.

Now, I wish to call to your attention, that, if we have a flask graduated in this manner, we may, at any temperature, obtain indications to verify the scales of areometers.

If the temperature of the liquid is different from 15°, and the areometer marks 1.5 specific gravity, the indication is not correct on account of the variation of the volume of the liquid and of the areometer.

But if we keep the liquid at the same temperature, and place it in the flask, so as to fill the volume, which, at 15°, holds 100 grammes of water, and we find that the weight of the liquid is 150 grammes, we may conclude that the areometer which showed 1.5 sp. gr. was correct.

The reason for this conclusion is, that, although both indications are incorrect, the error depends on the expansion of glass and the expansion of the liquid, and these are exactly the same in both cases; therefore, if these errors were eliminated, the equality would still persist.

To express this preposition algebraically, suppose that a and b are the indications that we would have at 15° with the areometer and the flask respectively, and that x and y are the errors in each case from operating at a temperature different from 15°. If $a+x=b+y$, and if at the same time $x=y$, then $a=b$.

XXXI—Proceedings.

Regular Meeting, Thursday, September 5th, 1878.

Vice-President Chandler in the chair.

The minutes of the previous meeting were read and approved.

The following report of the meeting of the Board of Directors, held July 16th, 1878, was presented:

Present—Mr. Casamajor, in the chair, and Messrs. Eastwick, Habirshaw, Endemann, Goldmark, Sherer, Shapleigh and Alsberg.

A bill of Messrs. Baker & Godwin, for $228 for printing, was approved and ordered to be paid.

The following resolutions were adopted:

1. That the Committee on Papers and Publications be authorized to publish the Proceedings of the Society for the next three months.

2. That the Treasurer be requested to notify all delinquent members and associates to pay their dues, and to call their attention to Article 5 of the By-Laws; that he shall report at the September meeting the names of all those who have not complied with his request.

3. That the Treasurer be requested to state, at the next meeting of the Board of Directors, the balance of funds then at the disposal of the Society.

4. That, it being desirable to have No. 4 of Vol. I of the Pro-

ceedings printed and distributed as soon as possible, the members who have not yet presented their papers for this number, be requested to send in their contributions before September 1st.

The following were elected:

As members—H. G. Debrunner; W. P. Mason; W. H. Greene.

The following was proposed:

As member—Mr. Chas. Upham Shepard.

Adjourned.

M. ALSBERG,

Recording Secretary.

THE AMERICAN CHEMICAL SOCIETY.

XXXII.—Proceedings.

Regular Meeting, October 3rd, 1878.

Vice-President Silliman in the chair.

The minutes of the previous meeting were read and adopted.

Dr. C. U. Shepard, Jr., was elected a member. Mr. G. F. Cruse was proposed for membership. Prof. Froebel sent in his resignation, which was accepted.

The following were elected a committee to make nominations for officers of the Society for 1879: Prof. Chandler, Dr. Endemann, Mr. Casamajor; with instructions to report a list of officers at the next meeting.

Prof. Silliman gave an account of the state of chemistry as it appeared in the Paris Exposition, mentioning, among others, Cailletet's apparatus for the liquefaction of gases; an exhibit of the rarer metals, especially those of the platinum group; a new alloy of two per cent. of nickel and ninety-eight per cent. of aluminium, which is hard, does not tarnish, and is characterized by its excessive lightness (and therefore, perhaps, well adapted for subsidiary coins); the progress made in the electric light; the autogenous soldering of platinum, an alloy of ninety per cent. of platinum and ten per cent. of iridium, which has a smaller coefficient of expansion than any other metal; the artificial production of precious stones; the splendid exhibit of nickel by Mr. J. Wharton, of Philadelphia, &c. Prof. Silliman said that there was a plate of palladium of one decimeter in diameter, and one millimeter in thickness, which, after absorbing one thousand volumes of hydrogen, had its shape permanently altered from that of a flat plate to that of a cup, while, at the same time, all its dimensions were increased.

Adjourned.

M. ALSBERG,
Rec. Sec.

XXXIII.—Proceedings.

Regular Meeting, Thursday, Nov. 7th, 1878.

Vice-President Casamajor in the chair.

The minutes of the previous meeting were read and adopted.

The Board of Directors reported as follows: At a meeting held Oct. 17th, 1878—present Mr. Casamajor, in the chair, and Messrs. Endemann, Nichols, Havemeyer, Habirshaw, Goldmark, Eastwick, and Alsberg—the Treasurer handed in the affixed report, according to which there is a balance in bank to the credit of the Society of $1,253 65.

The following bills were audited and ordered to be paid: Baker & Godwin, $70; H. Endemann, $25 53.

On motion of Mr. Habirshaw, it was resolved to pay the Assistant Librarian $5 a week, and $2 a month for cleaning the rooms of the Society. The Treasurer also requested authority to employ a collector, which was granted.

The Committee on Publications was authorized to publish the Proceedings for the last quarter of 1878.

It was resolved that the Librarian be requested to purchase a complete set of Berzelius-Liebig's Jahresbericht der Chemie at the lowest price, and to furnish the Board of Directors with a list of the works which he has selected for the library.

Mr. E. F. Cruse was elected a member.

The following were proposed:

As members—Messrs. C. W. Drew, Edgar Everhart, Dr. Ira Remsen.

The first paper, by Prof. F. P. Dunnington, treated on a new method for the determination of copper. The chairman remarked that a convenient volumetric method for the determination of copper was an object very much desired, but not accomplished yet. The next paper, by the same author, treated on the presence of manganese in the ash of wheat, whose blue color had hitherto been ascribed to the formation of ultramarine, but is really due to some manganate. This was confirmed by Dr. Waller, who found it also in the ash of bread, flour, yeast and potatoes. The next paper was by Dr. Battershall: Note on fibrous sodic chloride. Dr. Morton had a paper read on the Elimination of antimony from the human system, in which he proved that antimony can be easily detected in urine, by directly passing H_2S through it, without having previously destroyed the organic mat-

ter. In the discussion which followed, the chairman said that he doubted that it was necessary to destroy the organic substances previous to treating with H_2S. In the case of solutions of sugar or molasses, to which enough HCl is added to make them distinctly acid, H_2S in a short time precipitates the metallic substances, especially tin; the familiar brown precipitate soon makes its appearance. He mentioned particularly the case of tin, because it has recently been stated that it is quite generally used by sugar refiners.

The Nominating Committee reported the following for officers for 1879:

President:

T. STERRY HUNT.

Vice-Presidents:

F. A. GENTH, A. R. LEEDS,
A. B. PRESCOTT, E. R. SQUIBB,
IRA REMSEN, W. M. HABIRSHAW.

Corresponding Secretary: P. CASAMAJOR.

Recording Secretary: WALDRON SHAPLEIGH.

Treasurer: W. H. NICHOLS.

Librarian: ELWYN WALLER.

Curators:
P. DE P. RICKETTS,
J. B. F. HERRESHOFF,
C. M. STILLWELL.

Committee on Papers and Publications:
H. ENDEMANN,
A. BEHR,
S. A. GOLDSCHMIDT.

Committee on Nominations:

R. A. FISHER, HANBURY SMITH,
G. M. MILLER, A. BOURGOUGNON,
G. A. PROCHAZKA.

Board of Directors:

A. R. LEEDS, E. WALLER,
E. R. SQUIBB, C. F. CHANDLER,
W. M. HABIRSHAW, H. ENDEMANN,
P. CASAMAJOR, J. GOLDMARK,
W. SHAPLEIGH, C. H. SCHULTZ,
W. H. NICHOLS, G. M. MILLER,
E. P. EASTWICK.

On motion of Dr. Chandler, it was resolved that the ticket of officers for 1879, with a list of the members and a copy of the constitution and by-laws be mailed to every member, with a request to return his vote for officers for the next year, at once.

The motion of Mr. Beckwith—to post the names of delinquents who have not paid their dues for 1876 and 1877, with the amounts which they owe, in the rooms of the Society—was carried.

Adjourned.

M. ALSBERG,
Rec. Sec.

XXXIV.—New Method for the Determination of Copper.*

By F. P. DUNNINGTON.

In a paper read before the American Philosophical Society, December, 1877, by Prof. Edgar F. Smith, of the University of Pennsylvania, an article was given on the determination of copper by precipitation with sodium carbonate, and then boiling until the carbon dioxide is expelled.

The delay required for the boiling, which is also attended with some bumping, may be avoided by the following modification of that method, and with the additional advantage that the precipitate does not adhere to the vessel used.

To the boiling dilute solution of copper, gradually add a solution of sodium carbonate to slight excess, then add a dilute solution of sodium hydrate, until the precipitate blackens, when it will readily settle, and may be washed by five or six decantations with boiling water.

10.026 grms. of electrotype copper were dissolved in sulphuric acid; the solution was divided by weighing. The copper found by elec. deposition, in a bright film, from two equal portions of the solution, weighed 1.0059 grms. The trace of iron remaining in the solution was also estimated:

Giving { Cu.— 99.943
Fe.— .067 .

Two larger weighed portions of the solution were precipitated by the method above:

1st. Precipitated in 10 min., washed in 70 min. with 2 litres water, by 6 decantations, the CuO weighed 2.5165 grms., giving of the Cu present 100.13 p. c.

2d. Precipitated in 10 min., washed in 80 min. by 5 decantations, the CuO weighed 2.5257 grms., giving of the Cu present 100.16 p. c.

In no case was the filtrate found to contain more than .0002 grms. Cu, which was no doubt due to the pores of the filter paper; and con-

* Since completing the above, I find that the method has been used by others for some time; as, however, I can find no statement of it in print, it may be well to publish these results. F. P. D.

sidering the large weight of the precipitates, this method appears most satisfactory.

UNIVERSITY OF VIRGINIA, June, 1878.

XXXV.—MANGANESE IN THE ASH OF WHEAT.

BY F. P. DUNNINGTON.

IN the examination of some specimens of Virginia wheat ("Lancaster" and "Fultz"), my attention was called to the fact that the purified ash, obtained by exhausting the crude ash with nitric acid and evaporating to dryness, gives, when exposed to a dull red heat, a pink-tinted mass.

Finding that in six of the seven specimens examined the color was of about the same intensity (in the seventh the color was fainter, the ash having probably been heated a little more), I concluded to endeavor to ascertain to what it was due.

The ash of 300 grammes of "Dark Lancaster" wheat was exhausted with nitric acid, and after separating the iron, the ammonium sulphide precipitate was found to contain manganese, and gave, by fusion with nitre and sodium phosphate, a violet-colored mass.

The ammonium sulphide filtrate evaporated to dryness with nitric acid, and heated, gave no pink color.

The total amount of manganese was found to be .00144 grm., corresponding to .027 per cent. of the pure ash.

As this ash is composed mainly of alkaline phosphates, it is evident that the color is due to the manganese, and similar to that of the violet mass from which "Nüremberg violet" is made.

It seems of interest to make note of this apparent constant occurrence of so small an amount of an element not regarded as essential to this grain, as I have not been able to find any previous mention of it.

In the analysis of three specimens of oats, Mr. J. P. Norton found .72 to .92 per cent. in the ash. See Aschen-Analysen v. Dr. E. Wolff, page 26.

UNIVERSITY OF VIRGINIA, June, 1878.

XXXVI.—NOTE ON FIBROUS SODIC CHLORIDE.

BY S. P. BATTERSHALL, PH. D.

AN interesting and, to me at least, rare crystalline modification of sodic chloride was brought to my notice some time since by Dr. W. M. Habirshaw. Through the kindness of this chemist, I obtained specimens of the mineral referred to, and was thus enabled to submit it to

analysis and recrystallization. The salt was found in a cargo of Peruvian guano, and possesses the beautiful *fibrous structure* shown by the accompanying specimens, which have been freed, to some extent, from an incrustation of ferric oxide and other foreign substances. An analysis gave the following result:

	PER CENT.
Water	0.729
Sodic chloride	95.336
Potassic chloride	2.259
Potassic sulphate	0.202
Magnesic sulphate	0.755
Calcic carbonate	0.361
	99.642

Traces of silica, alumina and nitrates were also found to be present. It should be remarked that a much larger quantity of lime and magnesia was found in samples which contained more of the amorphous salt noticeable at the end of one of the specimens here presented. This uncrystalline portion consists, to a large extent, of calcic and magnesic carbonates. Upon recrystallizing the purified fibrous salt, it was obtained in perfect cubes, which were found to be nearly pure sodic chloride, a mere trace of potassic chloride being present. It will be noticed that, in the above analysis, the greater part of the sulphuric acid is combined with the magnesia; and it need scarcely be added that it could, with equal right, be accounted for as sodic or potassic sulphate. But, in any case, the fact that above 4 per cent. of foreign saline ingredients modify in a marked degree the crystalline form of sodic chloride appears to be indicated. And this, I considered, a sufficient excuse for calling the attention of the Society to the subject.

XXXVII.—Note on the Elimination of Antimony from the Human System.

By HENRY MORTON, Ph. D.,

President of the Stevens Institute of Technology.

In hopes of throwing some light on certain points connected with the elimination of antimony from the human system, concerning which there seems to be a degree of discrepancy, or at least uncertainty, in the works of the standard authorities on toxicology, the following experiments were made by the present writer. Though they are far from exhausting the line of investigation indicated, it is believed that they at least establish some valuable data, and build up some few paces of the desired road.

In order to secure material for analysis, tartar emetic, in doses of half a grain each, was administered every evening about ten o'clock, for three successive days, and the urine discharged collected in two portions for each twenty-four hours—one being that discharged at rising in the morning, and the other consisting of the rest discharged at various times during the day and evening.

The analyses were conducted as follows: The fluid was concentrated to about one-third its volume by evaporation on the water bath, hydrochloric acid then added, and sulphureted hydrogen passed through, with occasional warming for about twelve hours. The precipitate was then separated by filtration, and thoroughly washed until no trace of chlorine could be detected in the filtrate, with nitrate of silver. The filter (paper and all) was then oxydized by repeated treatment with strong nitric acid, and evaporated to dryness; and further, carbonized by the action of strong sulphuric acid, aided by a moderate heat not over 160° C.

When a portion of the charred mass yielded a colorless solution in boiling water, the whole was pulverized and digested with hot water containing a little hydrochloric acid.

The clear, colorless liquid was then separated from the carbon by filtration, and treated with sulphureted hydrogen and warmed.

Antimony, when present, was then precipitated in minute flocks, with its characteristic orange color, as hydrated ter-sulphide.

An assertion having been very confidently made that such a treatment as the above would fail to detect small amounts of antimony, because the organic matter present would prevent its precipitation by sulphureted hydrogen, it was thought worth while to settle that question once for all by a decisive experiment, although the intrinsic improbability and unsupported character of the assertion hardly entitled it to so much attention.

Accordingly, in several cases after the first treatment with sulphureted hydrogen, the liquids passing through the filter and the washings were concentrated, oxydized with nitric acid then with hydrochloric acid and chlorate of potash, and heated on the water bath until the smell of chlorine had nearly disappeared. Water was added from time to time to replace that lost by evaporation. Sulphureted hydrogen was then passed through the liquids, and their precipitates were treated as before.

In no case was the slightest trace of antimony discovered in any of the filtrates thus treated, from which it evidently appeared that none had escaped the first precipitation with sulphureted hydrogen and that no advantage would have been gained by the application of the much more elaborate treatment involved in partially oxydizing the organic matter in the first instance.

The general results are here given in tabular form, as the most convenient and explicit:

June 18th, 10 P. M. First dose of ½ grain administered.
" 19th, 6 A. M. Collected urine, 7½ ozs. Slight orange precipitate.
" " to 10 P. M. Collected urine, 17 ozs. Orange precipitate less than the previous one.
June 19th, 10 P. M. Second dose of ½ grain administered.
" 20th, 6 A. M. Collected urine, 9¼ ozs. Orange precipitate in larger amount than the first.
" " to 10 P. M. Collected urine, 15 ozs. Orange precipitate larger than any before.
June 20th, 10 P. M. Third dose of ½ grain administered.
" 21st, 6 A. M. Collected urine, 7¼ ozs. Orange precipitate like the previous one.
" " to 10 P. M. Collected urine, 17¼ ozs. Orange precipitate like the last.
June 22d, 6 A. M. Collected urine, 12 ozs. Orange precipitate less than those of previous day.
" " to 10 P. M. Collected urine, 18 ozs. Orange precipitate larger than morning of the same day.
June 23d, 6 A. M. Collected urine, 9 ozs. Orange precipitate less than on previous day.
" " to 10 P. M. Collected urine, 19 ozs. Orange precipitate larger than in the morning.
June 24th. Entire quantity collected, 24 ozs. Orange precipitate about equal to second lot of June 23d.
June 25th. Entire quantity collected, 30 ozs. Yellow color appearing slowly, small precipitate only after standing 10 minutes.

The above observations and results would indicate that antimony, when swallowed even in very small doses, is very promptly eliminated, in part by the kidneys, and continues to be so eliminated constantly. With such small doses as were here employed it is not likely that the elimination could have been traced much further than it was in these experiments, namely, for five days after the last dose.

The rate of elimination during these five days was steadily decreasing, the difference between the morning and later collection being simply such as should result from the larger quantity obtained in the second lot.

Whatever was the state of combination of the antimony on its elimination, it certainly was one which offered no obstruction to its precipitation by sulphureted hydrogen, when applied in the usual manner.

XXXVIII.—Proceedings.

Regular Meeting, Thursday, December 5th, 1878.

Vice-President Casamajor in the chair.

The minutes of the previous meeting were read and adopted.

After a few remarks of the Vice-President, on the present state of the Society, the Treasurer, Librarian and Curators presented their reports, which were accepted. There is a balance in bank to the credit of the Society of $1,208 44.

The exact amount due the Society from all sources is difficult to state, but is about $2,300. Of this amount it is probable that we can collect only about $1,500. Many members upon the books have never paid anything, and many more have never paid after their first remittance.

I would here earnestly express the wish that members would immediately remit the amount of their dues, upon receiving notification, before the matter slips from their minds. I am satisfied that many are delinquent simply from forgetfulness. It is not fair that such should be dropped from our rolls until every means of collecting from them has been exhausted; but I would advise the appointment of a Committee to revise our list of members, and report such names as they deem advisable to have dropped from the roll.

The Librarian reported as follows:

Report of the Librarian.

The Librarian congratulates the Society upon the present state of the library as affording promise of collecting, in time, a large and valuable library. The library, it is true, is small, but contains already many standard works, as well as some valuable on account of their distinguished authors or the time at which they were published. It is unnecessary to rehearse the vicissitudes of the Society before it attained a local habitation, and until that was accomplished, the collection of books was impossible. The list of acquisitions of the library during the past year, therefore, includes really an entire catalogue of the present library. This is given in the lists appended. Without here giving the titles, the *resumé* of these lists is as follows:

Books purchased, 12 works, 175 volumes.

Books presented to the library, 54 works, 169 volumes.

Beside these, the Society has on its shelves 6 works, in 21 volumes, loaned by members to supply, so far as possible, the present deficiencies

of the library, until the Society can acquire possession of copies, by gift, exchange or purchase.

The list of contributors to the library includes the names of twenty-seven, almost all of whom are active or associate members of the Society.

The receipt on behalf of the Society of a dozen portraits of eminent chemists, of two engravings, and of tables of elements and spectra, for the adornment of our walls, may also be mentioned here.

A summary of the property of the Society in the charge of the Librarian includes, therefore, 65 works, in 344 volumes, divided as follows:

Periodicals	11 works.
Dictionaries and other books of reference	10
Books on special subjects	17
Pamphlets	27
Pictures and diagrams	19

The necessity of obtaining exchanges treating of current events in the world of chemistry is too obvious to need more than a passing reference. The Librarian hopes to be able to report, at the end of the coming year, a gratifying increase in that department.

With regard to the loan collection, although it is true that most chemists owning valuable books of reference for their own use, desire to have them on their own book-shelves, yet if such works can be temporarily spared by the members, and do not happen to be as yet in the possession of the Society, it is to be hoped that they can be placed on the library shelves for general use, so long as the owners may be able to do so, and thereby subserve one of the main objects of the Society, which I understand to be mutual aid and assistance in the pursuit of the science of chemistry. The idea of a loan collection originated, I believe, with Mr. Casamajor; and too much cannot be said in favor of its kindly reception by the other members of the Society.

The Librarian also desires to direct the attention of the members to another point. The Society is by no means wealthy, and there are unmerous works which it should possess, which, if not presented to it, must be purchased. The members who have the welfare of the Society and its objects at heart are earnestly requested to present to the Society what books they may have, or may become possessed of, and, at least, to present to the library such books or papers as they may, from time to time, have already published, in order that the Society may possess a record of the work of its members in the science in which we all are, it is to be hoped, earnest and faithful workers.

For List of Books in the Library, see pages 155–159.

The Society then proceeded to the election of officers for the year 1879. The ticket as agreed upon at the last meeting was found to have been elected. Mr. Shapleigh, however, declining to serve as secretary, on account of a prospective removal from New York, Dr. S. A. Goldschmidt was elected in his stead, and the vacancy thus caused on the Committee on Papers and Publications filled by the election of Dr. G. E. Moore.

The Chairman appointed the following committees: On Rooms—Messrs. Waller, Goldschmidt and Rossi; and on Conversaziones—Messrs. Rossi and Nichols.

The following were elected:

As members—Messrs. Ira Remsen, Edgar Everhart and C. W. Drew.

The following were proposed:

As members—Messrs. H. M. McIntyre and and G. W. Wigner.

Professor A. R. Leeds read the following papers:

Upon the alteration of standard ammonia solutions, when kept in the dark.

Upon the importance of the element of time in the performance of certain titrations.

Efficiency of chemical methods of ozonation.

Upon the determination of nitrates.

Dr. Waller remarked, that it seemed to him, that in making the test with starch and KI, iodine is slowly liberated in some unexplained manner.

Dr. Moore gave his experience about the purification of HCl, SO_3 and N_2O_5.

The Chairman called the attention of the Society to the fact that in this month occurs the centennial anniversary of the birth of Guy-Lussac and Sir Humphrey Davy, of which the Society ought to take cognizance. It was resolved to celebrate the anniversary by a supper at the next conversazione, and to invite President Johnson to deliver an informal address.

Adjourned.

M. ALSBERG,
Rec. Sec.

XXXIX.—Upon the Alteration of Standard Ammonium Chloride Solution, when kept in the Dark.

BY ALBERT R. LEEDS, Ph. D.

In February, 1877, M.M. Schloesing and Muntz communicated to the French Academy (Comptes Rendus, lxxxiv, 301) the results of

elaborate experiments tending to prove that nitrification was due, in certain cases, to the action of an organized ferment. They further showed, that nitrification could be arrested in such cases by the vapor of chloroform, and would not set up again until after the filtered sewage employed had been freshly "seeded" by the washings of a soil which was known to nitrify. These observations were verified and extended by R. Warington (Chem. News, xxxvi, 262, 1877), who showed, that chloroform and carbon disulphide effectually prevent nitrification in certain cases, while carbolic acid is probably effective to the extent in which it comes in contact with the soil. Moreover, that the action of the nitrifying body does not occur at all in the light, darkness being apparently essential. In a note upon the ferment theory of nitrification, by Prof. F. H. Storer (Chem. News, xxxvii, 268), he states, that a solution of ammonium chloride, which had been prepared ten or twelve months previously, gave a strong reaction for nitrites. It had been preserved in a half-filled glass-stoppered bottle, put away in a dark cupboard. Similar solutions, seeded in various ways, but left in a strong light for a number of months, gave no reaction whatever for nitrites or nitrates. The following experiments confirm these results, so far as the change of the ammonium solutions in the dark is concerned, and give the rate at which it may be expected to occur under ordinary circumstances.

A standard solution of ammonium chloride had been prepared October 15th, 1877, by dissolving 0.7867 grm. NH_4Cl, purified by repeated sublimation, in a liter of re-distilled water, free from ammonia. Another solution was prepared by diluting 100 c.c. of this water to 1 liter, and used constantly during the months of October and November, 1877, in making the estimations, which will be found recorded in article entitled "Contributions from the Laboratory of the Stevens Institute of Technology." * They were put aside in a dark closet, and remained there until this autumn, when a new standard ammonium chloride solution was prepared, from a fear lest the old solutions had altered. This proves to have been the case. A careful determination, as ammonio-platinic chloride, of the ammonia contained in 250 c.c. of the stronger solution, gave 0.0575 grm., or 0.00023 grm. in 1 c.c., instead of 0.00025, the amount which the solution originally contained. Instead of being perfectly limpid, as it was when made, the solution contained a number of white filaments, looking like the vestiges of some vegetable growth. The more dilute solution presented the same appearances, but not to so marked a degree.

25 c.c. of the solution were used in the examination for nitrites, but

* Proceedings Amer. Chem. Soc. Vol. II.

only a trace could be shown in this large quantity of the liquid. 5 c.c. of the solution were evaporated 3 times to dryness in a platinum dish with 0.1 grm. of caustic soda, prepared from sodium, and which had been found entirely free from nitrogen compounds. It was then distilled with 6 grms. pig iron in a vessel made entirely of glass, the pig iron having been previously repeatedly distilled with water, until it and the vessel had ceased to give any reaction for ammonia. The distillate contained 0.03 mgrm. H_3N, equivalent to 0.11 mgrm. HNO_3, or 0.022 mgrm. HNO_3 per cubic centimeter.

Two methods of avoiding this change are suggested by the above: 1st. Keeping the ammonium solutions not in the dark, as generally happens, but in the light. 2d. Addition of a drop of chloroform or carbon disulphide. The disulphide is inapplicable, speedily blackening the Nessler re-agent; the chloroform in our possession was not entirely without action, but it was so slight as to be hardly appreciable when a drop was diffused in a considerable amount of water. 1 liter of standard ammonium chloride solution, containing 0.25 mgrm. H_3N per c.c., was divided into four parts, each part being placed in a ¼-liter bottle. A piece of a fungus found rapidly growing in a bottle of sodium acetate, after repeated washing, was put in each bottle. A drop of chloroform was introduced into two of the bottles, one of which has been placed in the light, the other in darkness. The bottles without chloroform have been similarly placed, and it is proposed, after a suitable interval, to determine what changes, if any, have occurred in them.

XL.—Upon the Titration of Hydrochloric Acid for Chlorine, and of Sulphuric and Nitric Acids for Hyponitric Acid.

BY ALBERT R. LEEDS, Ph. D.

I have never been fortunate enough to purchase hydrochloric, sulphuric and nitric acids, nominally C. P., without finding that the first contained chlorine, and the other two hyponitric acid. It is well known that nitric acid, exposed to light, becomes gradually contaminated with hyponitric acid, and Dr. G. E. Moore informs me, that hydrochloric acid, exposed to sun-light, is very apt, if concentrated, to suffer a species of decomposition or dissociation, so that after a time it nearly always contains chlorine. It became important, in certain experiments, to determine the percentage of these impurities in nominally pure acids. The amount of sodium hyposulphite solution required to titrate the iodine set free by the hyponitric acid in 1 c.c. H_2SO_4, diluted to the customary degree, was 0.15 c.c. = 0.00075 grm. iodine. When 1 c.c. of the same sulphuric acid was diluted with 1000 c.c. water, potassium

iodide solution and starch water added, it colored very slowly, and on titration at the end of two hours was equivalent to 0.28 c.c. $Na_2S_2O_3$. Allowed to stand, it turned blue again, and at the end of 22 hours required 0.3 c.c. more of $Na_2S_2O_3$ to decolorize it. These results led to the following experiments: 1 c.c. HCl was diluted with 1000 c.c. water, and potassium iodide and starch added. The results obtained on titration with sodium hyposulphite are indicated in column I. The results with 5 c.c. of the same acid are given in column II. With 1 c.c. H_2SO_4, in III. With 1 c.c. H_2SO_4, boiled with potassium iodide and starch, and afterwards cooled before titration, in IV. With 1 c.c. HNO_3, in V. Other samples of these acids, sent by the same manufacturer as undoubtedly free from these impurities, were similarly titrated, and the results are given in column VI for the hydrochloric, VII for the sulphuric, and VIII for the nitric acid. In every case 1 c.c. acid was diluted with 1000 c.c. water. A liter of distilled water, to which potassium iodide and starch had been added, standing in the same place with the others, did not alter, showing that there was nothing in the atmosphere of the room which produced this slow progressive change. The total number of cubic centimeters of sodium hyposulphite, which would have been required had the acids themselves decomposed the potassium iodide in these highly dilute solutions, is given in the bottom line of the table.

	I	II	III	IV	V	VI	VII	VIII
Immediately	No color	0.70 c.c.	None	——	None			
2 hours	0.42 c.c.	1.80	0.28 c.c.	——	0.24 c.c.			
24 hours	0.40	0.25	0.30	——	0.30			
54 hours (Oct. 30th)	0.04	0.07	None	1.50 c.c.	0.05			
November 4th	0.10	0.26	0.47	0.76	0.62			
" 9th	0.19	0.14	0 39	1.18	0.31			
" 15th	None	0.20	0.95	None	0.45			
" 18th	None	0.18	0.50	None	0.04	1.20 c.c.	1.37 c.c.	0.70 c.c.
" 25th	0.05	0.27	0.88	0.06	0.20	0.15	1.72	0.41
" 29th	0.08	0.20	0.70	None	0.05	0.70	1.60	0.70
December 5th	None	0.25	0.70	0.10	0.15	0.77	1.75	0.50
Sum	1.23 c.c.	3.82 c.c.	5.17 c.c.	3.60 c.c.	2.41 c.c.			
	318 c.c.	1590 c.c.	982 c.c.	982 c.c.	390 c.c.			

The causes of these changes, and a satisfactory method of titration, will be given in a future communication to the Society.

XLI.—Upon the Determination of Nitrates.

BY ALBERT R. LEEDS, Ph. D.

The ordinary apparatus, which is used in the determination of nitrates when present in minute quantities, gives erroneous results, and when employed qualitatively to prove or disprove the presence of a very small amount of a nitrate, fails altogether. This apparatus con-

sists of a flask, closed with an India-rubber cork, through which a Welter's safety-tube is passed, and an exit-tube passing down through a cork into a comparison-tube, such as is used in Nesslerizing, and which serves as a condenser. After such an apparatus is very carefully cleansed, even with re-distilled water not containing a trace of ammonia, it will give, even after repeated distillations of pure water, a distillate capable of re-acting feebly upon the Nessler re-agent. This is much more the case when the flask contains a copper-zinc couple, or the finely-divided gray pig iron, such as I have recently proposed for estimation of nitrates in alkaline solution. An example will show this more clearly: 4 grms. of fine zinc turnings were treated with a solution of cupric sulphate, and the resulting copper-zinc couple thrown on an asbestos filter and washed twenty times with distilled water, at last in the ammonia-free, re-distilled water, in all about 1250 c.c. A second portion was treated in like manner. Distilled as above, in flasks through which water, in portions of 50 c.c. each, had been thrice distilled, until no further re-action for ammonia was obtained, they gave the following results:

	Copper-Zinc.	Pig Iron.
1st distillation, 50 c.c. water,	0.04 mgrm. H_3N.	0.03 mgrm. H_3N.
2d " " "	0.01 " "	0.01 " "
3d " " "	0.01 " "	0.03 " "
4th " " "	0.05 " "	0.01 " "
5th " " "	0.03 " "	0.01 " "
6th " " "	0.01 " "	0.01 " "
7th " " "	0.02 " "	0.02 " "
8th " " "	0.01 " "	— " "
Total.....	0.18 " "	0.11 " "

The larger amounts were obtained when the distillation was carried to dryness. The distillations were interrupted at the 8th, but it is probable that like results would have been procured, had the operations been prolonged indefinitely.

A much simpler apparatus should be used, which also gives entirely reliable results. It is merely a small glass stoppered retort, with its neck thrust as far down as it will go into the comparison-tube. The latter is placed in cold water, and no joints of any kind are employed in the apparatus. A copper-zinc couple was prepared as above, and the results are given in column A, distillations 4th, 5th and 6th. In column B, the results with 6 grms. pig iron. In each column, 1st, 2d and 3d are the results of distilling pure water through the apparatus, after it has been cleansed by repeated washing.

				A With Water.		B With Water.	
1st distillation,	50 c.c.	water,		0.01 mgrm.	H_3N.	0.01 mgrm.	H_3N.
2d	"	"	"	0.0075 "	"	0.0025 "	"
3d	"	"	"	0.0025 "	"	0.0025 "	"
				With CuZn.		With Iron.	
4th	"	"	"	0.01 mgrm.	H_3N.	0.02 mgrm.	H_3N.
5th	"	"	"	0.005 "	"	0.005 "	"
6th	"	"	"	0.0025 "	"	—— "	"

In other words, in qualitative tests by this method for minute amounts of the oxygen compounds of nitrogen, it is necessary not only to do without rubber corks, and to distill water through the apparatus until no further re-action for ammonia is obtained, but also to cleanse the reducing agent *in the still* by repeated distillations before introducing the body to be tested. In the process of transfer to the still of 4 grms. of the copper-zinc couple, after it had been completely washed, it and the still had acquired by contact with the atmosphere of the laboratory, sufficient nitrogenous particles to afford a re-action, in three distillates, equivalent to 0.0175 mgrm. H_3N.

These results afford an explanation of the apparent production of minute amounts of ammonia, when pig iron was distilled with pure soda,* and of the slight excess obtained, when small amounts of alkaline nitrates were reduced by a very large excess of pig iron. Using the new form of apparatus above described, and the various precautions suggested by so numerous trials, pig iron, after completely cleansing in the manner narrated, was distilled with different amounts of caustic soda. In no instance, where all the precautions were observed, was a trace of ammonia obtained, and we can, therefore, affirm, that *the samples of pig iron employed, distilled with alkali alone, do not evolve ammonia.*

To determine whether the pig iron in great excess completely reduced small quantities of alkaline nitrates, 6 grms. pig iron, perfectly cleansed, were distilled 3 times with 50 c.c. water, and 0.0061 grm. KNO_3. A plus result was not obtained, the amount of ammonia in the distillates agreeing closely with the theoretical. Pig iron alone, therefore, can be successfully employed to effect the reduction of the minute amounts of alkaline nitrates, obtained in the course of analysis of natural waters.

To determine to what extent alkaline nitrates would undergo reduction, when present in comparatively large quantities, 6 grms. pig iron

* Contributions from the Laboratory of the Stevens Institute of Technology. Proc. Amer. Chem. Soc. Vol. II, p. 6.

were distilled to dryness with 0.48 grm. KNO_3 and 75 c.c. water in a flask connected with a Liebig's condenser. The distillate contained 0.0034 grm. H_3N = 0.0202 grm. KNO_3, or 4.2 per cent. In this case, the pig iron amounted to 13 times the weight of the alkaline nitrate; in the former to 1000 times. In this case, therefore, to effect complete reduction of an *alkaline nitrate*, pig iron alone is not sufficient; some free alkali must be added.

XLII.—Action of Potassium Permanganate upon Oxalic Acid.

BY ALBERT R. LEEDS, Ph. D.

In a paper entitled "Contributions towards a knowledge of the Chemical Constitution of the Atmosphere," * I stated, that when the two solid substances, crystallized oxalic acid and potassium permanganate, in powder, were mixed together, they liberated ozone on addition of water. Vacation intervening, the study of this and similar re-actions was not resumed until five months later, in October of the present year, when it was found that other organic acids yielded the same apparent results, more especially tartaric and acetic acids. The deportment of the inorganic acids varied: Nitric acid added to potassium permanganate liberated a gas plenteously, which affected the potassium iodide papers, but the gas evidently contained nitrous acid, and, when passed through water, had no effect upon the test papers. Hydrochloric acid gave negative results, but chromic acid produced with the permanganate an apparently copious solution of ozone.

An attempt was then made to determine the amount of ozone apparently given off. 20 grms. of pulverized oxalic acid were introduced into a half-liter flask, which was provided with a glass funnel and stopcock for the introduction of a saturated solution of potassium permanganate, and an exit-tube connecting with a wash-bottle containing water. The corks used in this and the other experiments were boiled in paraffine, and the joints luted with the same. The escaping gas, after passing through the wash-bottle, was made to traverse a Geissler absorption apparatus, containing a decinormal solution of potassium iodide. The action was allowed to go on for a week at common temperatures, the permanganate being added in successive portions, until the oxalic acid was completely decomposed. 9 liters of air were drawn through the apparatus, after which the flask was gently warmed, and 9 liters more of air drawn through it. No change whatever had taken place in the potassium iodide. The entire experiment was carefully repeated with identical results.

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* Annals of the N. Y. Academy of Sciences, Vol. I, No. 7.

This unexpected conclusion threw suspicion on the methods of ozone-generation, in which potassium permanganate is decomposed by an acid, and more particularly that in which sulphuric acid is employed. For this reason, the same apparatus was used as in the above experiment, but 25 grms. pulverized permanganate were introduced into the flask, and sulphuric acid run in through the funnel, a drop at a time. Much caution was used in conducting the operation, but even then one flask was blown to pieces, after the re-action had been going on for several hours. In each of three trials, the potassium iodide remained unchanged, but chlorine was found in the wash-water. This led to an examination of the re-agents employed, with the result of finding that the potassium permanganate contained 0.164 per cent. of potassium nitrate, and 7.47 per cent. of other impurities, principally potassium chlorate, but along with it some manganic oxide, insoluble silicious residue, and a minute amount of potassium chloride. A trace of chlorine was likewise found in the oxalic acid. Analyses of other nominally chemically pure preparations were made with similar results, the least impure containing 97.06 per cent. potassium permanganate, with 0.148 per cent. chlorate, a trace of chloride, some manganic oxide, and sand. The percentage of manganese, in the potassium permanganate first spoken of, determined gravimetrically, by precipitation as sulphide, solution in hydrochloric acid, reprecipitation as carbonate, and estimation as proto-sesquioxide, was 31.50 per cent., instead of 34.66, the theoretical amount. The manganese percentage determined volumetrically, by means of ammonio-ferrous sulphate, was 32.78, showing the influence of the admixture of chlorate upon the oxidation of the iron.

At this stage of the inquiry, I found that the same sources of error had previously been exposed by C. Rammelsberg (Berichte der Deutsch. Chem. Gesell. VI, p. 604), who showed that the potassium permanganate, which he experimented upon, contained only 27.3 per cent. of manganese, the difference being due to 21.6 per cent. of potassium perchlorate. He also found, that, when the permanganate, free from chlorine, was used, no smell was developed by the action of sulphuric acid, and the re-action upon iodo-starch was so weak that it evidently arose from a trace of chlorine.

It gives me much pleasure to acknowledge the co-operation of my assistant, Dr. Edgar Everhart, in the performance of these experiments.

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